SEPTEMBER 1951
No. 176

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ASTM Bulletin

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PAPERS—Micro-Hardness Testing; Test of No-Retention Time of Traffic Paints; Fiber Properties; Stiffness in Textile Fabrics; Electronic Flexometer for Testing Fabrics and Plastics; Particle Interlocking on Strength of Cohesion Soil; Temperature Measurements in Mooney Viscometer.

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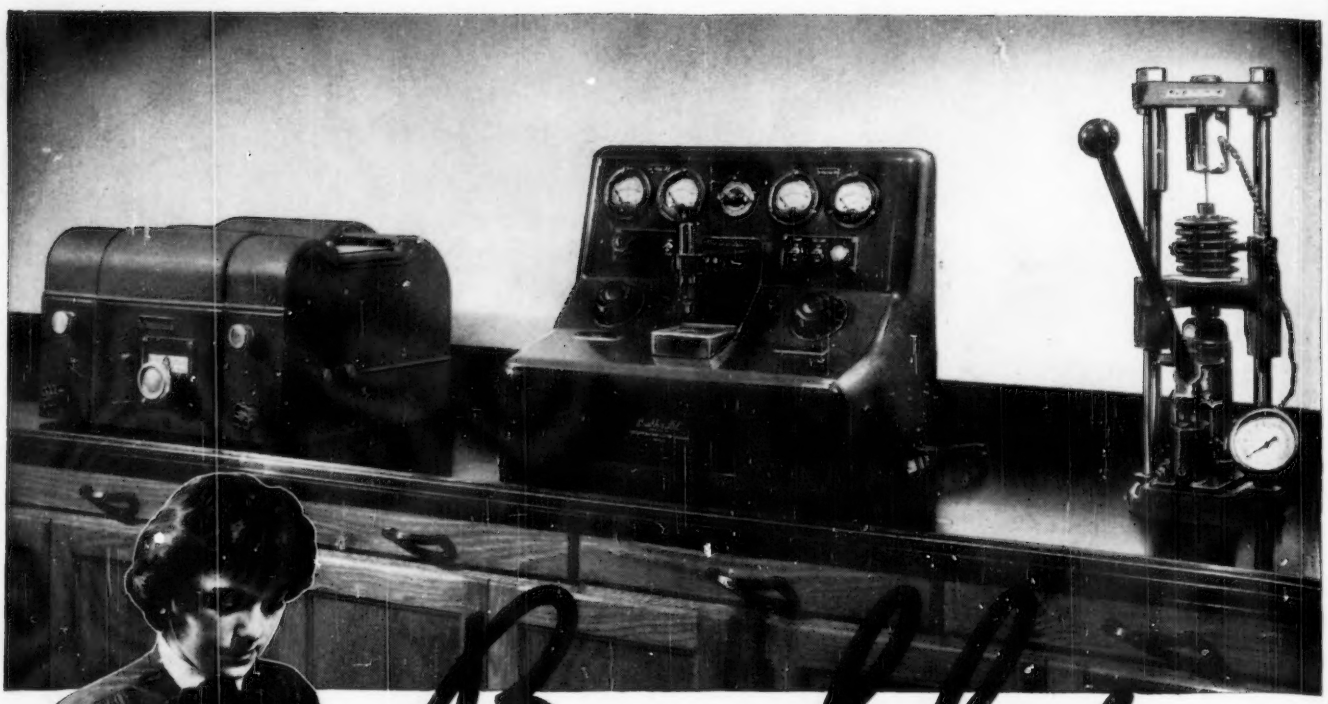

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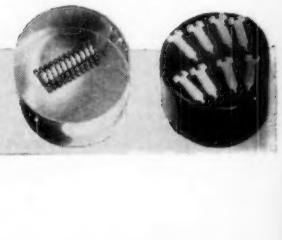

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ASTM BULLETIN

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AMERICAN SOCIETY for
TESTING MATERIALS

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1902—50th Anniversary Meeting—1952

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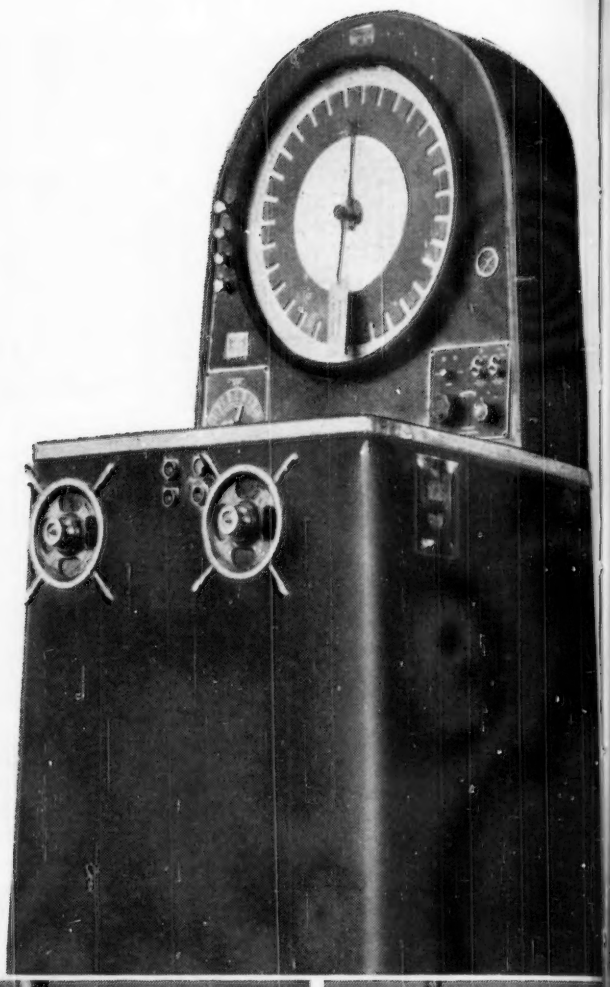
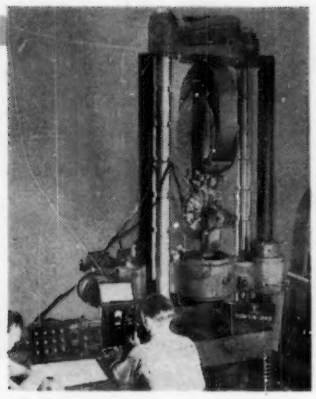
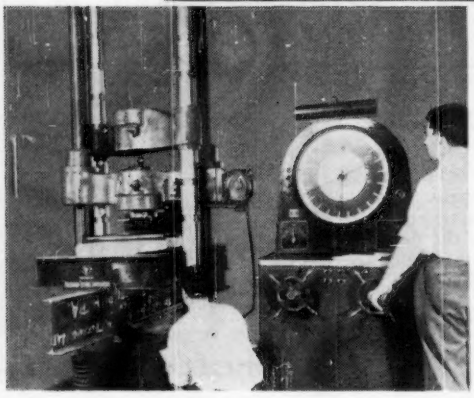
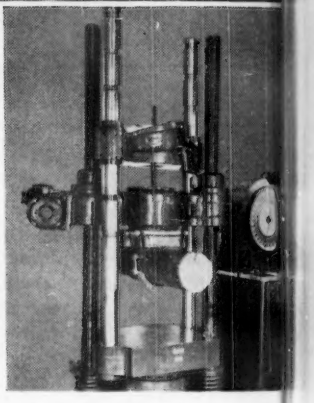




A 300,000 lb. B-T-E Universal Machine and Baldwin SR-4® strain gages team up for a traveling block and hook assembly test in Dallas.



Deflection test on light weight aggregate concrete pre-cast roof slab in a 200,000 lb. B-T-E machine at Pittsburgh headquarters.



Testing a four-way strain band used for lumber on a 300,000 lb. B-T-E Machine in the P.T.L. San Francisco Branch.

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Number 176 SEPTEMBER, 1951

New and Revised ASTM Standards for Chromium Alloys, Adhesives, Thermal Analysis of Steel, Testing Building Panels, Estimating Grain Size of Non-Ferrous Metals, Thermostat Metals

Emergency Alternate Provisions in Steel Tubing Specifications, Steel Tires, and Heat-Treated Steel Tires

BY ACTION of its Administrative Committee on Standards, the American Society for Testing Materials on July 10 approved a number of emergency alternate provisions in several of its alloy tubing specifications, and approved several new specifications and revisions. Notes on some of these actions follow; see p. 27 for the emergency alternates.

Steel Tubing and Pipe Specifications:

A number of emergency alternates for steel tubular products have been approved in line with the procedures established by the Board of Directors. The scarcity of certain alloying elements is necessitating the use of scrap that may be high in phosphorus, and the loss of heats which fail to meet the present phosphorus limits is becoming increasingly serious. Therefore, for the specifications itemized below it has been recommended that the present limit on check analysis for phosphorus content be increased from 0.030 per cent maximum to 0.045 per cent maximum:

Standard Specifications for Seamless Cold-Drawn Intermediate Alloy-Steel Heat Exchanger and Condenser Tubes (A 199–46),

Standard Specifications for Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200–46),

Standard Specifications for Welded Alloy-Steel Boiler and Superheater Tubes (A 249–47), and

Tentative Specification for Seamless Alloy-Steel Boiler and Superheater Tubes (A 213–50 T).

In addition to the above-mentioned provisions emergency alternates have also been approved for five stainless steel tubing specifications as listed below:

Standard Specifications for Seamless and Welded Ferritic Stainless Steel Tubing for General Service (A 268–47),

Standard Specifications for Seamless and Welded Austenitic Stainless Steel Tubing for General Service (A 269–47),

Standard Specifications for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing (A 270–50),

Standard Specifications for Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service (A 271–47), and

Tentative Specifications for Seamless and Welded Austenitic Stainless Steel Pipe (A 312–48 T).

With the present critical shortage of all materials, the steelmaker endeavors to reduce all the chromium in the slag so that it will be present in the metal. The silicon reduction of chromite in the slag leads to phosphorus reversion. Due to the shortage as much chromium as possible is recovered, even at the risk of obtaining a higher phosphorus content. The average phosphorus content is already higher than two years ago and sometimes a heat of steel is produced which meets all requirements except that it is a few points high in phosphorus content. The emergency alternates recommended for the specifications listed provide that the present limit of 0.030 per cent maximum phosphorus be increased to 0.040 per cent maximum on ladle analysis and 0.045 per cent maximum on check analysis.

Steel Tires and Heat-Treated Steel Tires:

The emergency alternate for Steel Tires (A 26–39) and Heat-Treated Steel Tires (A 329–50 T) applies only to acid steel tires. A request was forwarded that due to the critical scrap situation, the maximum limitations for phosphorus and sulfur be raised from 0.05 to 0.06 per cent maximum as an emergency.

The emergency alternate provision in Heat-Treated Tires (A 329–50 T), applying to both basic and acid steel, in the opinion of the manufacturers, would not affect the quality of the heat-treated tires. By changing the manganese range from 0.60 to 0.90 per cent to 0.50 to 0.90 per cent, manufacturers will be able to use portions of a melt intended for untreated tires to fill small orders for heat-treated tires.

Iron Alloys for Sealing to Glass:

To meet the needs of the electronics industry, ASTM Committee B-4 on Electrical Heating, Resistance, and Related Alloys completed the new tentative specifications for 17 and 28 per cent chromium-iron alloys for sealing to glass (B 256 and B 257). In these applications important characteristics of the material include thermal expansion and microstructure. Specific tests are given to determine thermal expansion, namely a reference to ASTM Methods E 80 or a shorter method appended to the specifications. The requirements

Are you interested in?: Action on Standards—p. 5; ASTM Publications—p. 7; Industrial Exposure Test Sites—p. 12; ASTM 50th Anniversary—p. 14; District Activities—p. 16; Standardization Activities of Technical Committees—p. 18; Micro-Hardness Testing—p. 37; Test of No-Dirt-Retention Time of Traffic Paints—p. 44; Fiber Properties—p. 46; Stiffness in Textile Fabrics—p. 49; Electronic Flexometer for Testing Fabrics and Plastics—p. 52; Particle Interlocking on Strength of Cohesionless Soil—p. 55 Temperature Measurements in Mooney Viscometer—p. 60.

Actions by the ASTM Administrative Committee on Standards, August, 1951

New Tentatives

Specifications for:
17 per cent Chromium-Iron Alloy for Sealing to Glass (B 256–51 T)
28 per cent Chromium-Iron Alloy for Sealing to Glass (B 257–51 T)
Methods of:
Test for Resistance of Adhesives for Wood to Cyclic Accelerated Service Conditions (D 1183–51 T)
Test for Strength of Adhesives on Flexural Loading (D 1184–51 T)

Revision of Tentative

Method of:
Conducting Tests of Panels for Building Construction (E 72–47 T)

Revision of Standard and Reversion to Tentative

Recommended Practice for:
Thermal Analysis of Steel (E 14–33)
Methods of:
Testing Thermostatic Metals (B 106–40)
Method of:
Modulus of Elasticity of Thermostat Metals (B 223–50)
Estimating the Average Grain Size of Non-Ferrous Metals and Their Alloys, Other Than Copper and Copper Base Alloys (E 91–51 T)

Emergency Alternate Provisions

Specifications for:
Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199–46) (EA–A 199)
Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200–46) (EA–A 200)
Welded Alloy-Steel Boiler and Superheater Tubes (A 249–47) (EA–A 249)
Seamless Alloy-Steel Boiler and Superheater Tubes (A 213–50 T) (EA–A 213) Seamless and Welded Ferritic Stainless Steel Tubing for General Service (A 268–47) (EA–A 268)
Seamless and Welded Austenitic Stainless Steel Tubing for General Service (A 269–47) (EA–A 269)
Seamless and Welded Austenitic Stainless Steel Sanitary Tubing (A 270–50) (EA–A 270)
Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service (A 271–47) (EA–A 271)
Seamless and Welded Austenitic Seamless Steel Pipe (A 312–48 T) (EA–A 312)
Steel Tires (A 26–39) (EA–A 26)
Heat-Treated Steel Tires (A 329–50 T) (EA–A 329)

on microstructure which apply to the 17 per cent alloy indicate that after heating to 1100 C in air and held for 15 minutes, followed by water quenching, a sample at 500 diameters magnification shall be substantially free of austenite or other transformation products.

Accelerated Testing of Adhesives and Flexural Strength:

The new test for resistance of adhesives for wood to cyclic accelerated service conditions (D 1183) will meet the need in the wood joining or wood laminating field for a means of predetermining the usefulness of a given adhesive under stated types of continued cyclic service conditions. The scope of this method is as follows:

These methods of test cover procedures for determining the resistance of adhesives for wood to cyclic accelerated service conditions by exposing bonded wood specimens to conditions of high and low temperatures and high and low relative humidities. The extent of degradation is determined from changes in strength properties as a result of exposure to the test conditions. This method is intended for use with the plywood shear specimen described in ASTM Standard D 906.

It is recognized that no accelerated procedure for degrading materials correlates perfectly with actual service conditions and that no single or small group of laboratory test conditions will simulate all actual service conditions. Consequently, care must be exercised in the interpretation and use of data obtained in this test.

The test procedure, the number of cycles of the test procedure to be used, the particular strength property to be used to determine the extent of degradation, and whether test specimens or test panels are to be used must be specified in the material specification.

The new test for strength of adhesives on flexural loading (D 1184) has found practical application in determining adhesive deterioration under accelerated aging conditions and in determining the relative usefulness of one glue compared with another in a stated construction. Its scope is as follows:

This method of test covers procedures for determining the comparative properties of adhesive assemblies when subjected to flexural stresses with standard shape specimens and under defined conditions of pretreatment, temperature, relative humidity, and testing technique. The test specimen and testing technique were designed to develop a large portion of shear forces between the laminae of the test piece, when the load is applied rather than to reduce shear stress to a minimum as is done in other ASTM methods of test for flexural properties. This method is not applicable to assemblies made with nonrigid adherends. The data obtained are not suitable for design work.

Thermal Analysis of Steel:

Extensive revisions in the recommended practice for thermal analysis of steel (E 14) modernize the requirements and expand the coverage not only for steel but to include all metals and alloys.

Average Grain Size of Non-Ferrous Metals and Their Alloys:

The new Tentative Method for Estimating the Average Grain Size of Non-Ferrous Metals and Their Alloys Other Than Copper and Copper Base Alloys (E 91–51 T) has been under preparation for a number of years and covers procedures for estimating and rules for expressing the average grain size of non-ferrous metals, such as aluminum, magnesium, and nickel, or their alloys, and applies to structures composed entirely or substantially of a single phase. This tentative includes three methods. The comparison method applies primarily to completely recrystallized or cast material with equiaxed grains; the intercept method is particularly recommended for grains that are not equiaxed; and the planimetric method shall be the referee method for material with equiaxed grains.

Revision of Methods of Testing Panels for Building Construction:

In 1947 the Society issued methods of conducting strength tests of panels for building construction (E 72). These covered tests of walls, nonload bearing partitions, floors, and roofs. Since then improved procedures have been developed and the latest revisions incorporate these as well as additional test procedures that will permit more complete evaluation of building construction panels, new or alternate methods of measuring deformations and an indication of the rate of loading for tests of this type. It is believed that the proposed revision will allow for better evaluation of panels for building construction than did the original tentative standard.

Copies of these revised specifications and methods can be procured from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., at nominal charge.

Thermostat Metals

IN ORDER to conform more closely with industrial practices, Revision and Reversion to Tentative of Standard Methods of Testing Thermostatic Metals (B 106 – 40) was adopted. The revision of the method called for a change of value of flexivity from 0.015 to 0.010 in., and for fixing the width of the test specimen with respect to thickness showing preferred widths.

The increase of the range of specimen size and gage length from between 0.020 and 0.050 in. to between 0.010 and 0.055 in. and the fixing of the gage length in relation to the thickness, thus conforming to current industrial practice were adopted in the Revision and Reversion to Tentative of Standard Method of Test for Modulus of Elasticity of Thermostat Metals (B 223 – 50).

Many Regular and Special Publications in 1951–1952

Includes Supplements to Book of Standards, Special Compilations and Publications, and Symposiums

THE publication schedule of the Society continues to grow each year as is evidenced by the number of publications listed below which cover a wide range of material. In addition to the regular publications—Supplements to the Book of Standards, *Proceedings*, Index to Book of Standards, and the Year Book—and the special compilations of standards, there are a great many symposiums and special publications to be published within the next few months.

Regular Publications

1951 Supplement to Book of Standards

The 1951 Supplements to the 1949 Book of Standards will be issued in six parts in heavy paper covers. They will include all new and revised standards and tentatives adopted or accepted at the Fifty-fourth Annual Meeting or by the Administrative Committee on Standards.

1951 Proceedings

The 1951 Proceedings (to be issued about March) will once again be a sizable volume, namely, around 1400 pages. The large size of this volume is to be expected because of the increasing number of technical papers with their discussions which are presented at the Annual Meeting and also due to the greater volume of committee reports because of the steady expansion of committee work into new fields. The papers and their discussions presented at the Annual Meeting as part of special symposiums will appear separately as special technical publications.

1951 Index to ASTM Standards

This Index continues to increase in value as the number of standards becomes larger, and again it will give the latest reference to publications where the various specifications and test methods appear. This volume is particularly significant in Supplement years in view of the increased number of standard books. Publication of this 1951 edition is scheduled for April and will aggregate some 270 pages.

1951 Year Book

The Year Book, which will be available early in October, contains a list of the complete membership and official company-member representatives (name, title, address, company, etc.), a list of geographical distribution of members, and personnel of all ASTM committees, as well as other pertinent information. This book is furnished to members on request.

Combined Index to Committee Reports and Technical Papers—1951

The policy followed in past years of bringing out a combined index of all technical papers and reports published in all of the Society's publications issued over a five-year period should have produced such an index to cover the years 1941–1945. The appearance of this index was postponed because of the postwar congestion in printing establishments throughout the country, and the situation was further complicated by the ever-increasing cost of printed matter. In addition to this the stock of three of the earlier combined indexes has become exhausted. In view of these conditions, the Administrative Committee on Papers and Publications decided to pass over the 1941–1945 index that had already become very much overdue, and bring out a 50-yr combined index to cover all publications of the Society up to 1950. Such a publication will present a very useful addition to all technical libraries and users of ASTM publications.

Special Compilations of Standards

The tabulation given on page 8 of special compilations of standards should be viewed as approximate only. There are so many factors affecting these books that it is not possible to give any accurate estimate of size or the date that they may become available. The size is affected by committee recommendations which may be submitted through the Administrative Committee on Standards, and the date of issue is governed somewhat by editorial considerations and the appearance of the Supplements to the Book of Standards, and also to a great extent by the tremendous load our printers are carrying.

Manual of ASTM Standards on Refractory Materials

This Manual is published for the primary purpose of bringing together in a convenient form all of the ASTM standard and tentative specifications, classifications, methods of testing, and definitions pertaining to refractories. It also contains certain other pertinent information of value in the testing and use of refractories, but not in the category of ASTM standards, such as a suggested procedure for calculating heat losses, a suggested practice for use with ASTM panel spalling tests, suggested petrographic techniques, standard samples for chemical analysis and Pyrometric Cone Equivalent determinations, and industrial surveys of service conditions of refractories. This volume is the result of the work of Committee C-8 on Refractories and is a revised and enlarged version of the 1948 edition. The increased interest exhibited in each edition—this will be the seventh—shows that the Manual serves a definite purpose and that it has become an important part of the literature on refractories. The book will be available around October and will contain approximately 280 pages. Some of the copies will be bound in cloth and others in heavy paper.

ASTM Manual of Engine Test Methods for Rating Fuels

A complete new edition of the Manual originally published in 1948 with Appendices issued in 1950 and 1951 will be available around January and will contain about 400 pages. This Manual will present in their latest approved form the five standard methods for rating motor, aviation, and diesel engine fuels. There will be a wealth of supplementary information concerning not only operation and maintenance details, but also building and utility requirements, installation and assembly of the engine, and reference fuels. In addition to the many drawings and photographs, there are numerous tables and charts contained in the publication. This Manual has proved to be of great interest to petroleum, automotive aircraft,

and related groups as it brings together under one cover the five widely used methods for rating engine fuels and the extensive supplementary information.

Manual on Industrial Water

Committee D-19 on Industrial Water is preparing a Manual designed for use by executives, industrial water engineers, chemists, and plant operators. The following chapters will be included:

I. Composition of Industrial Water Supplies and Water-Formed Deposits.
II. Uses of Industrial Water.
III. Difficulties Caused by Water in Industry.
IV. Treatment of Water for Industrial Use.
V. Sampling of Industrial Water and Water-Formed Deposits.
VI. Analysis of Industrial Waters.
VII. Identification of Water-Formed Deposits.
VIII. Analysis of Water-Formed Deposits.
IX. Glossary of Terms and Data.

The Manual will also include all of the ASTM standards and tentatives relating to industrial water. The inclusion of the methods in the Manual will supersede their publication as a separate compilation, for which there has been a considerable demand.

It is expected that the Manual will be available prior to the 1952 annual meeting.

Procedures for Emission Spectrochemical Analysis

Due to recent advances in emission spectroscopy, the variety of apparatus and techniques currently in use has become so large as to preclude standardization to the point that would enable the committee to write tentative methods. It was felt that the best approach to the problem was the collection of procedures that are currently being used. The committee has now completed the collection and preparation for publication of some 50 suggested methods for emission spectrochemical analysis, covering a wide range of materials and techniques. It is planned to publish these methods as a compilation which will be available around December.

Special Technical Publications, Symposiums, etc.

The following symposiums featured as part of the 1951 Annual Meeting will be published separately with discussion.

1951 Annual Meeting Symposiums

Symposium on Bulk Sampling.
Symposium on Consolidation Testing of Soils.
Symposium on Flame Photometry.
Symposium on Surface and Subsurface Reconnaissance.
Symposium on Measurement of Consumer Wants.
Symposium on Structural Sandwich Construction.
Symposium on Acoustical Materials.
Papers on Statistical Aspects of Fatigue.

Symposium on Bulk Sampling

The purpose of this symposium is to report on the important problems of sampling materials that occur in bulk form or in packages with the aim of estimating, at minimum cost, measurable characteristics of a quantity of material in order to get some prescribed limit of error with an assigned probability. Six papers by leading authorities comprise this symposium and a short description of each paper can be found in the May issue of the ASTM BULLETIN. The symposium is scheduled for publication in October.

Symposium on Consolidation Testing of Soils

The consolidation test is a fundamental strength test for soils not only for estimating the probable magnitude and time rate of settlement of foundations of structures, but also as the basic step in preconsolidating soil specimens for determining their essential shearing strength characteristics and stress-strain relations. This symposium is intended to bring together the varied experiences in consolidation testing of soils and knowledge of the nature of consolidation phenomena under varied controlling conditions in natural situations and as modified by structures and by construction methods and practices. The symposium includes eight papers; their titles along with a short description of the papers can be found in the May issue of the ASTM BULLETIN. This symposium should be available around January.

Symposium on Flame Photometry

The principle of flame photometry has been known for a good many years. However, the practical use of this principle has increased during the last few years as a result of the production of commercially available flame photometers. The analytical chemist has always been faced with a long, tedious method of chemical analysis for sodium, potassium, lithium, calcium, and magnesium. During the recent war years, the need for quick, accurate analyses of small amounts of sodium and potassium in blood probably accelerated the work of developing a flame photometer which could meet these specification requirements. Because of the importance to industry of testing methods, this symposium has been devoted entirely to methods of analysis by flame photometry so that information on new testing methods will be available. A short description of each of the eleven papers comprising this symposium can be found in the May issue of the BULLETIN. It is hoped that copies of this symposium will be available by November.

Symposium on Surface and Subsurface Reconnaissance

The purpose of this symposium is to assemble information on techniques that have been applied to this type of reconnaissance in widely varying scientific fields, and examine these techniques for their limitations as well as applications. Papers are divided into the four general groups: pedologic, geologic, air photo, and geophysical, in accordance with the procedures used for making the reconnaissance. Some describe applications of two or more methods in combination. Fourteen papers are included in this symposium and short summaries of these papers appear in the May issue of the ASTM BULLETIN. The symposium should be available in December.

Symposium on Measurement of Consumer Wants

ASTM's Administrative Committee on Ultimate Consumer Goods has found that standards for such goods must be based on what consumers want. Accordingly, this symposium was held to acquaint engineers with scientific development in this field. Three of the papers by the Quartermaster Corps discuss problems associated with determining soldier wants and the other four papers cover researches in measuring consumer wants. Summaries of these papers appear in the May issue of the ASTM BULLETIN. The publication date for this material is November.

LIST OF PENDING PUBLICATIONS

REGULAR PUBLICATIONS

1951 Supplements to Book of Standards
1951 Proceedings
1951 Index to ASTM Standards
1951 Year Book

COMPILATIONS, GROUPING OF STANDARDS AND MANUALS

Steel Piping Materials
Carbon and Alloy-Steel Plates for Boilers and Pressure Vessels
Rolled Structural Steel
Copper and Copper Alloys
Cement
Refractories
Paint, Varnish, Lacquer and Related Products
Petroleum Products and Lubricants
Engine Test Methods for Rating Fuels
Coal and Coke
Electrical Insulating Materials
Textile Materials
Definitions and Glossary of Terms on Textile Materials
Industrial Water
Plastics
Proposed Procedures for Emission Spectrochemical Analysis
Gypsum Plastering and Interior Lathing and Furring
Magnesium Oxychloride Flooring Materials
Thermometers

TECHNICAL PUBLICATIONS AND PAPER

Marburg Lecture
Report of the Elevated-Temperature Properties of Stainless Steels
Monograph on Paper and Paperboard
Manual on Engine Antifreezes
Bibliography on Electrical Contacts
Bibliography of Photoelectric Spectrophotometric Methods of Analysis for Inorganic Ions
ASTM-IP Manual of Oil Measurement Tables
Report of Joint Committee on Standard Specifications for Concrete and Reinforced Concrete
50-Year Index

Symposiums:

Triaxial Testing of Soils and Bituminous Materials
Thermal Insulating Materials
Papers on Soap
Consolidation Testing of Soils
Surface and Subsurface Reconnaissance
Bulk Sampling
Flame Photometry
Measurement of Consumer Wants
Structural Sandwich Construction
Acoustical Materials
Statistical Aspects of Fatigue

COMPILATIONS OF STANDARDS

Committee Sponsoring	Title	Approximate Number of Pages	Approximate Publication Date
A-1	Steel Piping Materials	350	Oct.
B-5	Copper and Copper Alloys	550	Dec.
C-1	Cement	240	Jan.
D-1	Paint, Varnish, Lacquer and Related Products	740	Jan.
D-2	Petroleum Products and Lubricants	900	Sept.
D-5	Coal and Coke	160	Sept.
D-9	Electrical Insulating Materials	700	Dec.
D-13	Textile Materials	610	Oct.
D-20	Plastics	650	Feb.

Symposium on Structural Sandwich Construction

A great deal of effort has gone into the development of structural sandwich constructions, primarily for the transportation and building industries. In aircraft, in particular, research and development have been most intensive, but the building industry also makes major use of such assemblies or walls, partitions, and other parts of buildings. Committee C-19 on Structural Sandwich Constructions sponsored this symposium for the benefit of all who are interested in obtaining a wider acquaintance with these constructions. The symposium consists of eight papers, summaries of which appear in the May issue of the ASTM BULLETIN. This publication will appear around December.

Symposium on Acoustical Materials

The problem of noise in our modern civilization is a most important one. One of the most widely used and effective methods for controlling sound and reducing noise is through the proper use of acoustical materials. Although such materials are today being used extensively in a wide variety of applications, there are very few test methods for determining the properties of these materials which have been universally agreed upon or accepted. It is the primary purpose of this symposium to discuss briefly the origin and history of the sponsoring Committee C-20 on Acoustical Materials and to outline the many problems which it is attempting to solve. Summaries of the eight papers comprising this symposium can be found in the May issue of the ASTM BULLETIN. Copies of this book will be available around the first of next year.

Papers on Statistical Aspects of Fatigue

Three papers are included in this symposium, one dealing with the importance of the statistical aspect of fatigue with respect to the planning of fatigue tests and of interpretation of their results; another gives hypotheses to explain the effect of size on endurance limit, fatigue life, and notch sensitivity; and the third paper deals with a statistical analysis of the experimental data and gives a method for plotting the curves of a constant which represent the fraction of the total number of specimens that fail at or below a certain number of cycles. Titles of these papers appear in the May issue of the ASTM BULLETIN. This symposium is scheduled for publication in January.

Symposium on Triaxial Testing of Soils and Bituminous Materials

This symposium combines papers presented at the Fifty-third Annual Meeting of the Society and three of those presented at a session on Bituminous Paving Mixtures, held at the First Pacific Area National Meeting in San Francisco. Subcommittee R-5C on Methods of Testing Soils Under Triaxial Loading of ASTM Committee D-18 on Soils for Engineering Purposes has realized that the standardization of a triaxial shear test for soils is of much importance but that it may take many years because of the varied concepts in this phase of soil mechanics and foundation engineering. This subcommittee has devoted much time and effort to discussions of these various concepts and to the testing equipment and procedures used by various soils laboratories throughout the United States. It accordingly sponsored this symposium designed to bring out some of the current thinkings on these subjects. The following papers will be included in this publication which will total approximately 310 pages and will be available in September.

History and Theory of Triaxial Testing, and the Preparation of Realistic Test Specimens—A Report of the Triaxial Institute—V. A. Endersby.

Some Concepts Concerning Triaxial Compression Testing of Asphaltic Paving Mixtures and Subgrade Materials—F. N. Hveem and H. E. Davis.

Application of the Triaxial Test to Bituminous Mixtures—California Research Corporation Method—V. R. Smith.

Application of Triaxial Testing to the Design of Bituminous Pavements—N. W. McLeod.

Triaxial Design Correlated with Flexible Pavement Performance in Kansas—H. E. Worley.

Triaxial Testing Adapted to Soils,

SYMPOSIUM ON CORROSION OF MATERIALS AT ELEVATED TEMPERATURES
SYMPOSIUM ON THE IDENTIFICATION AND CLASSIFICATION OF SOILS
SYMPOSIUM ON METHODS OF MEASURING VISCOSITY AT HIGH RATES OF SHEAR
Data on Corrosion- and Heat-Resistant Steels and Alloys —Wrought and Cast
ASTM
ASTM MANUAL on QUALITY CONTROL OF MATERIALS
SYMPOSIUM ON THE NATURE, OCCURRENCE, AND EFFECTS OF SIGMA PHASE
REPORT ON STANDARD SAMPLES FOR SPECTROCHEMICAL ANALYSIS 1950
1950
Index to ASTM Standards
Issued as of March 1951

Books of Service to Industry

Flexible Base, and Foundations—R. J. Hank.

A Triaxial Apparatus for Testing Large Soils Specimens—E. B. Hall.

Shear Testing at the Waterways Experiment Station—S. J. Johnson.

A Triaxial Shear Investigation on a Partially Saturated Soil—D. W. Taylor.

Shear Characteristics of Remolded Earth Materials—A. A. Wagner.

Application of Triaxial Compression Test Results to Highway Soils Problems—E. S. Barber and C. L. Sawyer.

The Importance of Natural Controlling Conditions Upon Triaxial Compression Test Conditions—D. M. Burmister.

Interpretation of Triaxial Compression Tests on Granular Mixtures—W. S. Housel.

Symposium on Thermal Insulating Materials

This symposium, consisting of five papers and their discussions, was presented at the Spring Meeting of the Society in March. This book which will be around 80 pages should be available in November. The symposium papers are as follows:

Basic Concepts of Water Vapor Migration and Their Application to Frame Walls—F. A. Joy.

Appropriate Methods for Measurement of Surface Emittance—L. P. Herrington.

The Measurement and Significance of Specific Heat of Thermal Insulating Materials—N. H. Spear.

A Comparison of Thermal Conductivity Determination Made on 20 Different Guarded Hot-Plate Apparatus.—H. E. Robinson

Experiments with a Guarded Hot Plate Thermal Conductivity Set—C. F. Gilbo.

In his paper Mr. Joy pointed out that excessive moisture in the walls of a frame dwelling is not a new condition but its prevalence increases as modern homes are built smaller and tighter. Mr. Herrington reviewed the terminology of radiation exchange from the standpoint of simplicity and usefulness in a standardized test suitable for use with structural materials as nonincandescent temperature radiators; he also described an apparatus construction for surface emittance measurement in the 0 to 300 F range. Primary problems in the practical field were discussed by Mr. Spear including an analysis of the effect of specific heat on the performance of building structures subject to different diurnal and seasonal temperature cycles, a consideration of pipe insulation practice, and a review of recent work in engineering properties of protective clothing. Mr. Robinson detailed a program of comparative thermal conductivity tests made on corkboard at a mean temperature from 20 to 120 F with 20 different guarded hot plates conforming to ASTM Methods C 177 – 45 in 17 different laboratories. The paper by Mr. Gilbo briefly describes studies made on an 8-in. square guarded hot plate thermal conductivity set designed as outlined in Methods C 177. The limits which must be met in order to operate this instrument successfully are discussed. The results of various experiments in which the operational limits are changed are included and show such things as: the effect of ambient temperature on guarded hot plate results, the effect of thermal unbalance between the heater and guard, and the correlation or errors in results with equipment faults.

Papers on Soap

Several significant technical papers were presented before Committee D-12 on Soaps and Other Detergents last March, and this material is being issued as a separate publication which should be available around November. The size of this book will be around 55 pages.

An *in-vivo* method for determining the skin-degerming efficacy of the product hexachlorophene when incorporated in soap has been presented by A. R. Cade together with a brief discussion of some of its variables and reasons for certain phases of the technique in a paper entitled "An *In-vivo* Method for Determining the Degerming Efficiency of Soaps Containing Hexachlorophene."

In a paper by I. J. Gruntfest on "The Mechanism of the Wetting of Textiles," consideration is given to the implications of the data on the wetting of textiles that is obtained by the use of hydrometer method. This method permits a much more detailed study of the wetting process than is possible by the more usual methods, and some effects of rate of immersion of skeins of gray cotton yarn, skein density, solution temperature, and mechanical action are described.

R. B. Mitchell's paper on "Practical Evaluation of Soiled Test Pieces" covers an evaluation of an over-all interpretation of soil removal results. Sixteen laundries were selected as trial plants for judging the efficacy of soiled test pieces in determining soil removal properties of a given detergent process.

In a paper on "Laboratory Performance Test for Detergents in Continuous Wool Scouring" by E. A. Leonard, the author points out that the usual criterion for cleanliness of scoured wool is residual wool grease content, determined by solvent extraction. Under this type of system, the comparison of detergents can be made only by (1) determining the average level and variability of results under standard conditions, and (2) running the detergent under test for sufficient time to redetermine mean level and variability under this new condition.

In his paper on "Measurement of the Adsorption of Anion-Active Detergents by Materials Commonly Washed" W. A. Fessler describes an analytical procedure for textiles which is also adaptable to other surfaces, namely metals and glass. It may also be used for measuring ease of rinsing by first measuring the amount of surfactant adsorbed and then titrating rinse waters.

1951 Marburg Lecture—Corrosion Testing

This excellent lecture was given by F. L. LaQue of the International Nickel Co. and will be available around November. The lecture comprises a survey of the corrosion-testing programs and the methods of corrosion testing which have been sponsored by ASTM. Mr. LaQue discusses the distinction that must be made between the corrodibility of a material and the protective value of its corrosion products and how these are influenced by both the composition of the material and the incidental conditions of its exposure. A few of the topics covered are: (1) relations between "acid" and other "accelerated" tests and the results of long-time atmospheric corrosion tests; (2) the relationship between the color and other characteristics of rust films and the durabilities of steels in the atmosphere and the prediction of performance on basis of rust color; (3) the influence of the corrosion resistance of steel on the performance of paint coatings; (4) the use and abuse of results of salt spray tests; and (5) discussion of advantages and limitations of ASTM corrosion methods. This very interesting lecture will comprise around 95 pages.

Report on the Elevated-Temperature Properties of Stainless Steels

This report is being sponsored by the ASMT-ASME Joint Committee on Effect of Temperature on the Properties of Metals and has been prepared by W. F. Simmons and H. C. Cross of Battelle Memorial Institute. It is essentially a graphical summary of elevated-temperature data for the commercially produced stainless steels. Included are summary curves for tensile strength, 0.2 per cent offset yield strength, per cent elongation, per cent reduction of area, stresses for rupture in 100, 1000, 10,000, and 100,000 hr, and stress for creep rates of 0.0001 and 0.00001 per cent per hr (1 per cent in 10,000 and 100,000 hr). An appendix is also included, which contains the primary data from which the summary curves were drawn. The data sheets in this appendix also give the chemical composition, processing data, and other pertinent information about the steels included in this survey. This 180-page publication will be available shortly, probably October.

Monograph on Paper and Paperboard

The 1944 edition of the Monograph on Paper and Paperboard has been brought up to date and it is expected that this 125-page publication will be available in October. This monograph provides an authoritative discussion of the characteristics of different types of paper, the significance of tests applied to them, and also paper terms and nomenclature. It has proved very useful in orienting the reader in the subject of paper evaluation so that he may ascertain in general the tests which may be employed to gain the knowledge desired relating to the utility of a specific paper for a particular use.

Manual on Selection and Use of Engine Antifreezes

Committee D-15 on Engine Antifreezes is sponsoring a Manual on Engine Antifreezes and it is felt that this publication will be of great interest to many. The purpose of this Manual is to provide consumers with practical information and advice on engine cooling system anti-

freeze and corrosion inhibitors. Other cooling system service products, such as cleaning compounds and stop-leaks, are also discussed. The references to cooling system services are confined to the practices directly affecting antifreeze, since the subject of general cooling system maintenance is already covered in published automotive literature. This publication will be illustrated and will contain around 20 pages. It is expected this manual will be available around October.

Bibliography and Abstracts on Electrical Contacts

A new combined edition of the 1944 Bibliography and its six supplements is now being prepared. This publication which will include all of the material in the 1944 volume and its supplements plus new material is really a monumental one and will be of outstanding service to all those concerned with this field. This very extensive annotated bibliography resulted from the work of ASTM Committee B-4 on Electrical Heating, Resistance and Related Alloys in developing standards covering electrical contact materials and determining effect of variables upon performance. It includes articles on contact materials and methods of testing and on the interruption of electrical circuits. It is expected that this 225-page volume will be available around October.

Bibliography of Photoelectric Spectrophotometric Methods of Analysis for Inorganic Ions

In the 1944 Symposium on Analytical Colorimetry and Photometry there was included a "Bibliography of Photoelectric Spectrophotometric Methods of Analysis for Inorganic Ions" which was prepared by J. W. Stillman. Since that time frequent requests have been received for an up-to-date revision of this bibliography. Accordingly, the bibliography has been amplified to include references up to the present date and will be issued as a separate publication about December, consisting of around 40 pages.

ASTM-IP Manual of Oil Measurement Tables

The Petroleum Measurement Tables being compiled jointly by the ASTM and the Institute of Petroleum (London) are now in the final stages of completion. It has been decided to publish the selected Tables in three volumes to meet the requirement of all countries, based on the following three approved systems of measurement: (1) U. S. System; (2) Imperial (British) System; and (3) Metric System. It is hoped that the U. S. and British volumes will be completed and made available early in 1952. The computation work for the more than 500 pages of Tables which will comprise the three volumes has been done jointly but independently by the ASTM and IP, after agreement was reached on the basic formulas and data to be used. The volume of American Tables will be published and made available by the ASTM. The British and Metric volumes are being published by the IP.

NOTES ON PUBLICATIONS

Important Special Compilations

ASTM Standards on Gaseous Fuels

THIS publication, released April, 1951, has been the result of work done by ASTM Committee D-3 on Gaseous Fuels.

The compilation contains one Standard Method of Test pertaining to Method of Test for Caloric Value of Gaseous Fuels by the Water-Flow Calorimeter and several tentative methods of test, of which the Analyses of Natural Gases by Volumetric Chemical Methods and by the Mass Spectrometer are worth while mentioning. In the Tentative Method of Sampling Natural Gas it should be pointed out that this method of sampling covers the procedures for the sampling of natural gas, containing different gases as contaminants such as: (1) natural gases containing primarily hydrocarbons and nitrogen, (2) natural gases containing hydrogen sulfide, or organic sulfur compounds, or other sulfur contaminants, (3) natural gas containing carbon dioxide, (4) natural gas containing gasoline and condensables. The difference in sampling procedures is mainly in degree, rather than in kind.

Copies of the 138-page compilation can be procured through ASTM, 1916 Race Street, Philadelphia 3, Pa. The price for nonmembers is $1.75, for members $1.35.

ASTM Standards on Rubber Products

(With Related Information)

THIS special compilation, issued May, 1951, includes in convenient compact form the 100 widely used standard and tentative test methods and specifications which have been developed through the work of ASTM Committee D-11 on Rubber and Rubber-Like Materials. The 656-page book should prove of great value to both producers and consumers of rubber products.

The following list of materials and subjects covered by standard tests and specifications will give some idea of the contents:

Processibility Tests
Chemical Tests of Vulcanized Rubber
Physical Tests of Vulcanized Rubber
Aging and Weathering Tests of Rubber
Low-Temperature Tests of Rubber
Automotive and Aeronautical Rubber
Hose and Belting
Tape
Electrical Protective Equipment
Rubber-coated Fabrics
Insulated Wire and Cable
Hard Rubber
Latex Foam, Sponge and Expanded Cellular Rubber
Rubber Cements
Rubber Latices
Packing Materials
Nonrigid Plastics
Electrical Tests
Nomenclature and Definitions

In addition to new material included in the book, many of the specifications and tests have been revised recently by the Society.

Particular attention is called to the inclusion of Emergency Alternate Provisions in this book. They will not permanently amend the specifications but leave a choice. These first emergency alternate provisions apply to Friction Tape (D 69) and Rubber Insulating Tape (D 119).

To bring the publication up to date, and provide the few changes in standards accepted at the June, 1951, annual meeting, as well as new specification, for gasket materials for general automotive and aeronautical purposes, D 1170, and method of test of weather resistance exposure of automotive rubber compounds, D 1171, the 1951 report of Committee D-11 is now being furnished. Members who procured copies of the compilation prior to the annual meeting may procure copies of the report on request.

Copies of this 656 page publication, bound in heavy paper cover, can be procured from ASTM, 1916 Race Street, Philadelphia 3, Pa., at $5.00 each to nonmembers, and $3.75 for members.

Important Progress in Atmospheric Exposure and Corrosion Work—Additional Tropical and Industrial Exposure Sites Established

Test Site Fund Passes $95,000 Mark

Less than three years ago the Advisory Committee on Corrosion undertook the task of establishing a nominal number of test sites which would be suitable for the exposure testing of ferrous and non-ferrous metals, paints, ceramics, rubber, adhesives, plastics, textiles, wood, etc., at the same time having conditions representative of the various sections of the country and offering also wide variations in the climatological conditions.

The number of sites which have been definitely established as of the present time is eight. These sites represent two tropical, two coastal (Atlantic Ocean and Pacific Ocean), two industrial, a semi-industrial, and a rural location. The committee still plans to establish a Gulf Coast site although the exact location has not as yet been decided upon. Consideration is also being given to the possibility of adding one more rural site.

The two new sites recently agreed upon are Fort Sherman in the Canal Zone and East Chicago, Indiana.

Although descriptions of some of the sites have appeared in an earlier issue of the Bulletin, it might be well briefly to summarize the conditions prevailing and facilities available at the various locations.

Exposure Sites

Tropical Sites

A mildly tropical atmosphere is represented by the Miraflores Canal Zone site. This site was made available by arrangement with the Panama Canal Zone authorities and tests are already in progress at that location. Other locations within the Canal Zone having a mildly tropical atmosphere and which might be made available through the same authorities are those at Gatun and Cristobal. All of these locations are relatively open and do not have the high humidity conditions encountered in the jungle.

In order to provide a site having *severe tropical* conditions similar to what would be found in the high temperature and humidity of the jungle, arrangements were made with the Naval Research Laboratory for permission to use part of the N.R.L. grounds at Fort Sherman which is located on the west coast (Atlantic Ocean side) of the Canal Zone.

Coastal Sites

The *Atlantic coast site* is at Kure Beach, North Carolina adjacent to the well-known test facilities operated by the International Nickel Company and is made available by agreement with that company. There will be no 80-ft tests made at this location. All specimens will be exposed at about the 800-ft mark which would afford comparison with the majority of the tests exposed by the Nickel Company.

Through the courtesy of the American Telephone & Telegraph Company an acre of land has been made available on the *Pacific coast* at Point Reyes, California, about 30 miles north of San Francisco. This location is representative of typical fog conditions of that region. Figure 1 shows the two pipe frames which have been completed and some of the footings for eight additional racks to be completed as needed. The site is enclosed with a four-strand barbed wire fence to keep out cattle which graze near by.

Industrial Sites

One of the first sites established by the Advisory Committee on Corrosion is that located in the New York *industrial area* on the roof of the 16th floor of the Port of New York Authority Building at 15th Street and Eighth Avenue. Two committees of the Society are currently using this location and sufficient pipe frames have been installed capable of holding more than 3000 specimens.

The second *industrial test site* is located in East Chicago, Indiana, on land made available to the Society by the Christiansen Corporation. This is the most recent site to be established. Within a radius of a few miles there are coke ovens, oil refineries, smelters, and other plants of an industrial nature.

Semi-Industrial Site

It was decided that a semi-industrial site having conditions about midway between those encountered in New York and State College, Pennsylvania was desirable and that Columbus would be a suitable location for such a site. A penthouse section of a five-story building has been made available to the Society through the courtesy of Battelle Memorial Institute. Three pipe frame supports have been erected there as shown in Fig. 2 and a number of specimen racks will be assembled and ready for use in the near future.

Rural Site

The rural site needs no introduction to many members of the Society, having been in use by a number of committees since 1925. This is the State College location made available through the Pennsylvania State College authorities and recently enlarged by an area of about 10,000 sq ft. The fact that this is a typical rural atmosphere has been borne out by tests extending over the past quarter century.

Financial Support Gratifying

The request for financial support of the test site program has been very gratifying, the amount pledged as of August 20 totaling more than $95,000.

In order to cover the cost of acquiring, maintaining, and supervising these test sites it was estimated that approximately

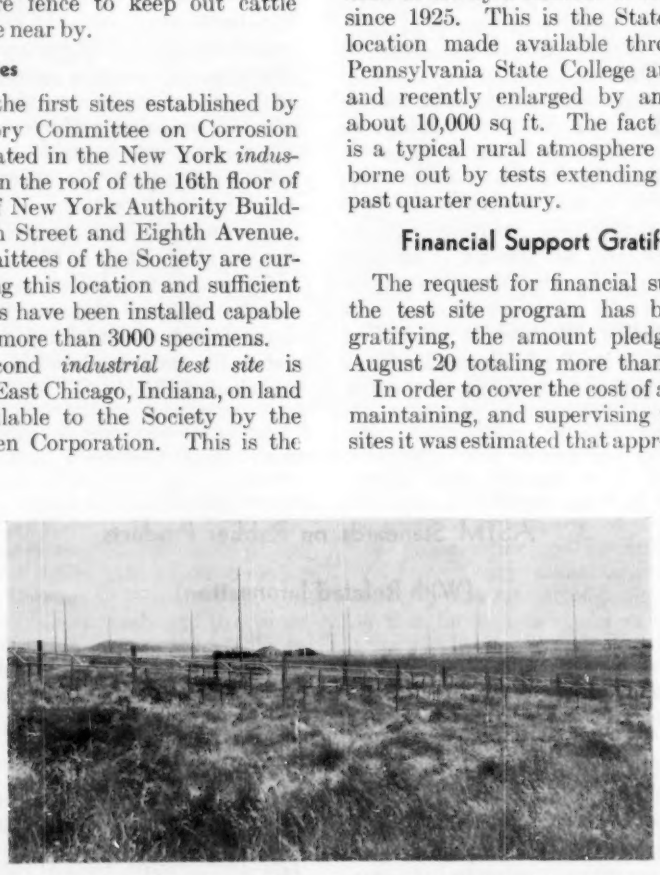

Fig. 1.—Completed Pipe Frames at Point Reyes, California, with Additional Footings for Additional Racks to Be Completed as Needed. (AT&T Receiving Station in background.)

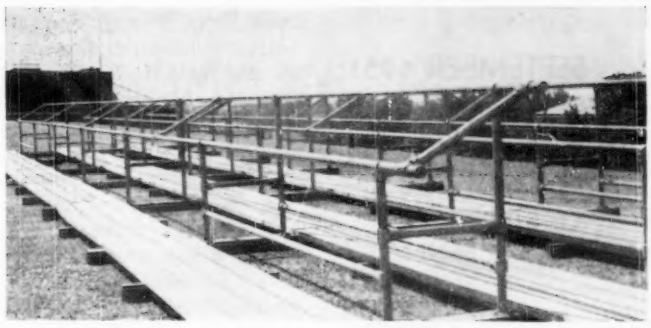

Fig. 2.—View of Completed Frames at Columbus, Ohio. (Note space available in front and behind completed racks as well as remainder of roof area in left background.)

$100,000 would be needed for the first 10 years. This would include the cost of equipping the sites with all test facilities—specimen racks, pipe frame supports, and various special items—enclosing them where necessary and providing a qualified engineer from the Society's Headquarters staff to give the necessary technical supervision and to service the sites under the general guidance of the Advisory Committee on Corrosion. It was agreed that an appeal for financial support should be made to those companies and individuals having the greatest interest in such a project, namely the producers and consumers of materials subject to atmospheric deterioration. This solicitation for funds was started by first approaching a number of selected companies until a substantial sum was obtained. This was followed up by two general appeals, by mailing invitations to about 825 interested individuals.

The $95,000 pledged represents contributions which have been received from 118 companies. Previous contributors were listed in the October, 1950, and the January, February, and May, 1951, issues of the ASTM BULLETIN. Those contributors not included in the previous issues are as follows:

Alan Wood Steel Co.
Aluminum & Magnesium Corp.
American Steel Foundries
American Viscose Corp.
American Zinc Institute, Inc.
Barnes-Bigson-Raymond, Div. of Associated Spring Corp.
Bonney-Floyd Co.
Boston Edison Co.
Braun & Co., C. F.
Caterpillar Tractor Co.
Conmar Products Corp.
Copperweld Steel Co.
Detroit Steel Products Co.
Driver, Wilbur B.
Durez Plastics and Chemicals, Inc.
Elastic Stop Nut Corp. of America
Electric Steel Foundry Co.
Gates Rubber Co.
General Railway Signal Co.
Harshaw Chemical Co.
Indiana Steel and Wire Co.
Inland Steel Co.
Kerite Co., The
Laclede Steel Co.
Lakeside Malleable Castings Co.
Lowe Bros.
Ohio Brass Co., The
Parker Rust-Proof Co.
Pennsylvania Forge Corp.
Publicker Industries, Inc.
Reichhold Chemicals, Inc.
Reynolds Metals Co.
Sargent & Lundy
Southern Electrical Corp.
Sperry Gyroscope Co.
Superior Die Casting Co., The
Thiokol Corp.
Titan Metal Manufacturing Co.
Twitchell, Inc., E. W.
United Chromium, Inc.
Utilities Research Commission
Whitney Blake Co.

There are undoubtedly a number of companies that have been considering making a contribution to the ASTM Test Site Fund and their contributions will be appreciated in order to reach the goal which was set. The original $100,000 goal was estimated as the lowest figure which would provide the absolute minimum of facilities. Any amount of money obtained over and above the $100,000 will be used to provide additional desirable facilities such as weather recording instruments, etc., at the various sites, as an aid to preparation and procurement of specimens by various committees, or merely held in abeyance for needs beyond the 10-year period.

ASTM Standards on Metallic Electrical Conductors

THE first edition of this publication released March, 1951, sponsored by Committee B-1 on Wires for Electrical Conductors, is intended primarily to present in a convenient form for reference the various ASTM standards, tentative specifications, and methods of test pertaining to metallic conductors, whether for use in uninsulated or uncovered form or for subsequent use in making insulated or covered conductors.

Included in the compilation are the copper bus bar and tube specifications under the jurisdiction of Committee B-5 on Copper and Copper Alloys, and the aluminum bus bar specifications under the jurisdiction of Committee B-7 on Light Metals and Alloys. Certain selected specifications prepared by Committee B-2 on Non-Ferrous Metals and Alloys covering the primary forms of copper, zinc, and lead that are used in the manufacture of the conductors covered by the specifications of Committee B-1 are also included. Part of the publication are also specifications and methods of test covering galvanized iron and steel guy wires, messenger wires, span wires, overhead ground wires, etc., prepared by Committee A-5 on Corrosion of Iron and Steel.

The resistivity values given in several of the standards in this compilation are based upon the International Annealed Copper Standard adopted by the International Electrotechnical Commission in 1913 and are expressed in terms of Absolute Ohm.

The publication bound in heavy paper consists of 222 pages, and can be obtained by writing to ASTM, 1916 Race Street, Philadelphia 3, Pa., at a price of $2.50 for nonmembers and $1.85 for members.

Corrosion Resistance of Metallized Steel

THE American Welding Society's Committee on Metallizing has organized a test program to determine the corrosion resistance of steel having metallized coatings of zinc and aluminum under exposure to different atmospheres.

Duplicate steel specimens will be sprayed with aluminum and zinc coatings varying in thickness from 0.003 to 0.015 in. with and without vinyl cover coats.

Preparation of the more than 4000 specimens to be exposed is already under way. When the specimens are completed early this fall, they will be assembled for exposure at standard corrosion test sites. Exposure will be for periods of one, three, six, and twelve years.

The test program is intended to provide authoritative data on what thickness of zinc or aluminum to use for different exposures for various lengths of time. The types of exposure include sea water, marine atmosphere, and different industrial atmospheres.

Arrangements will be made for examination of exposed specimens at regular intervals and for issuance of periodic reports. Anyone interested in securing a copy of the program or progress reports when issued may write to Secretary, AWS Committee on Metallizing, American Welding Society, 33 West 39th St., New York 18, N. Y.

ASTM Bulletin

SEPTEMBER 1951

NO. 176

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

● *1902—50th Anniversary—1952* ●

To BE sure, it's not yet 1952 but it won't be long until January 1 rolls around. Whatever next year may bring forth it should be a year that's of much interest to ASTM. Formally incorporated in 1902 as a national technical society, ASTM will be celebrating its 50th Anniversary as a national group.

Through the BULLETIN and by direct communication, members and others interested in the work will be kept informed of developments in plans which the Board of Directors has in mind. Particularly there are to be a number of special events during the 50th Anniversary Meeting at the Hotels Statler and New Yorker during the week June 23–27, inclusive.

A Committee on Arrangements, headed by Past-President J. R. Townsend, will develop and direct various features. An augmented technical program will be in keeping with the significance of the meeting. Many American and foreign bodies which cooperate or are concerned with our work will be officially represented. There will be the 10th Exhibit of Testing Apparatus and Laboratory Supplies, and the 8th Photographic Exhibit and Competition.

There will be special social and entertainment events for the men and the ladies.

What the weatherman will bring forth is uncertain. Some annual meetings in industrial centers have been held during relatively cool weeks. But even though the weather is hot, as it has been in the case of some it should be noted that the entire ballroom floor at the Statler, several of its other main function rooms which we will use, and many of the meeting and function rooms at the Hotel New Yorker are fully air-conditioned.

Every ASTM member and committee member who possibly can, and our many friends concerned with the field of materials, should come to this meeting. Block it off on your calendar early.

Actions on Standards Submitted to Members for Letter Vote

DURING the month of August a letter ballot was submitted for approval on proposals from the technical committees on 139 standards and tentatives. These proposals, as listed on the letter ballot, fall into two categories, namely, the adoption of tentative specifications and tests as formal standards, and the adoption of revisions in existing standards. There is also a proposed revision of the By-Laws on the nomination for honorary membership.

The letter ballot on the actions will be canvassed on September 30.

The Board of Director deems it desirable that all members in good standing should not fail to record their votes on all matters on which they feel technically qualified to vote; also that they should refrain from voting on other matters. Accordingly three columns have been provided on the ballot for "affirmative," "negative," and "not voting" records.

In connection with the actions on standards it should be noted that only by letter ballot of the entire Society membership can changes be made in the formal standards. The action in an annual meeting session alone or, in the interval between annual meetings, by the Administrative Committee on Standards (1) can approve for publication as *tentative* proposed new standards, (2) can approve *revisions in tentative standards* (which are incorporated immediately), or (3) can take action to permit publication of *proposed revisions in standards as tentative*. Many such actions, of course, are taken at the Annual Meeting and throughout the year by the Administrative Committee on Standards.

A complete list of items to be voted upon appears in the letter ballot being sent in a separate mailing to the members. Detailed information concerning matters referred to letter ballot is given in the committee reports issued in preprint form to the membership in advance of the meeting. The *Summary of Proceedings* accompanying the letter ballot contains a record of all actions taken at the Annual Meeting.

All newly adopted and revised standards will be published in the 1951 Supplement to the six-part 1949 Book of ASTM Standards. The Supplements will be mailed to the members in accordance with instructions on file at Headquarters. Details of the Society's extensive publication schedule is given somewhere else in this issue

Three More Sustaining Memberships

Three additional company members have authorized transfer to Sustaining Membership, making a total of 35 this year:

Baldwin-Lima-Hamilton Corp., Ralph Vezin, Acting Manager Metallurgical Engineering and Test Dept.

Certain-teed Products Corp., General Laboratory

Illinois Central Railroad Co., C. R. McEwen, Engineer of Tests

All these organizations have been affiliated with the Society for long periods, the Baldwin-Lima-Hamilton Corp. since 1911, the Certain-teed Corp. since 1915, and the Illinois Central Co. since 1904.

As previously noted in the BULLETIN, the Board of Directors of the Society is most appreciative of the support of some 240 of the country's leading companies through this class of affiliation.

Symposium on Filler Metal Specifications for Inert-Gas and Submerged-Arc-Welding

Organized by the AWS-ASTM Committee on Filler Metal, this symposium will be held at 2:00 P.M. on October 18, 1951, at the Hotel Book Cadillac in Detroit. Portions of the program cover inert gas and submerged arc welding processes for aluminum and magnesium stainless steels, copper and copper alloys, and mild and low-alloy steels. Consensus of opinion of the audience will serve as a guide to the Filler Metal Committee in determining its activity with regard to these processes.

1902—50th Anniversary Meeting—1952

Personnel of Board of Directors and Committees

THE By-laws of the Society specify that the Board of Directors shall appoint an Executive Committee which will exercise for the Board certain delegated authorities, and provision is made also for the appointment of other committees of the Board covering such phases of the work as membership, inter-society relations, finance, etc. The names of the members of the new Executive Committee and of the six other subcommittees, which will function during 1951–1952 are given below. Preceding this information there is published a complete list of the personnel of the Board of Directors with their respective titles and company affiliations

ASTM BOARD OF DIRECTORS

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(Vacancy)

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(Term Expiring in 1952)

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C. H. FELLOWS, Head, Chemical Division, Research Dept., The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

H. F. GONNERMAN, Assistant to Vice-President in Charge of Research, Portland Cement Assn., 33 West Grand Ave., Chicago 10, Ill.

N. L. MOCHEL, Manager, Metallurgical Engineering, Westinghouse Electric Corp., Lester Branch Post Office, Philadelphia 13, Pa.

M. O. WITHEY, Dean of Engineering, University of Wisconsin, Madison 6, Wis.

(Term Expiring in 1953)

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H. G. MILLER, Mechanical Engineer, Chicago, Milwaukee, St. Paul & Pacific R.R. Co., Milwaukee, Wis.

J. R. TRIMBLE, Assistant Manager, Department of Metallurgy Inspection and Research, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.

(Term Expiring in 1954)

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R. A. SCHATZEL, Vice-President and Director of Engineering, Rome Cable Corp., 330 Ridge St., Rome, N. Y.

E. O. SLATER, President and Manager, Smith-Emery Co., 920 Santee St., Los Angeles 15, Calif.

STANTON WALKER, Director of Engineering, National Sand and Gravel Assn., 1325 E St., N. W., Washington 4, D. C.

F. P. ZIMMERLI, Chief Engineer, Barnes-Gibson-Raymond, Division of Associated Spring Corp., 6400 Miller Ave., Detroit 11, Mich.

Past-Presidents:

R. L. TEMPLIN, Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, New Kensington, Pa.

J. G. MORROW, Metallurgical Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ont., Canada.

L. J. MARKWARDT, Assistant Director, U. S. Forest Products Laboratory, Madison 5, Wis.

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1951–1952

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Schedule of ASTM Meetings

DATE	GROUP	PLACE
September 10	General Committee on Arrangements for the 1952 50th Anniversary Meeting	New York, N. Y.
September 12	Joint SAE-ASTM Technical Committee on Automotive Rubber	Detroit, Mich.
September 13	Administrative Committee on Standards	ASTM Headquarters
September 13	Committee C-8 on Refractories	Bedford Springs, Pa.
September 17–18	Board of Directors Meeting	Philadelphia, Pa.
September 24	Organization Meeting, Committee D-23 on Cellulose and Cellulose Derivatives	ASTM Headquarters
September 27–28	Committee C-22 on Porcelain Enamel	Milwaukee, Wis.
October 4–5	Committee D-10 on Shipping Containers	Cleveland, Ohio
October 7–11	Committee D-2 on Petroleum Products and Lubricants	Chicago, Ill.
October 9	New England District	Cambridge, Mass.
October 10	Ohio Valley District	Louisville, Ky.
October 15–17	Committee D-13 on Textile Materials	New York, N. Y.
October 15–17	Committee C-16 on Thermal Insulating Materials	Canadensis, Pa.
October 23	Pittsburgh District	Pittsburgh, Pa.
October 24	Western New York-Ontario District	Buffalo, N. Y.
October 24–26	Committee C-1 on Cement, and Committee C-9 on Concrete	Lafayette, Ind.
October 25–26	Committee D-15 on Engine Anti-Freezes	Atlantic City, N. J.
October 26	New York District	New York, N. Y.
October 31	Northern California District	San Francisco, Calif.
November 1	St. Louis District	St. Louis, Mo.
November 2	Philadelphia District	Allentown, Pa.
November 8	Southern California District	Los Angeles, Calif.

Several District Meetings in October–November

President Fuller, F. L. LaQue Among Speakers

FROM THE schedule given below it will be seen that several of the ASTM Districts are planning meetings in October and November. A number of these are sponsored jointly by the ASTM Districts with other groups including local chapters of the American Society for Metals, and in other instances the local sections of other groups will be invited to attend.

Interesting Features:

While each member and committee member in the respective districts will receive a detailed announcement of the affairs, it is of considerable interest to note here that the Louisville meeting will be the first gathering of ASTM members in that city. This meeting, under the auspices of the Ohio Valley District, is being sparkplugged by Fred C. Smith, Tube Turns, Inc., a Council member and very active in ASTM work.

The Northern and Southern California meetings are of particular interest also, since the technical speaker will be the 1951 Edgar Marburg Lecturer, F. L. LaQue, International Nickel Co., who will highlight his Marburg lecture as the technical feature of these meetings. The California Councils were very anxious to have him present, and each district there has arranged the participation of several other local sections, so that a large meeting is in prospect in both San Francisco and Los Angeles.

President Fuller, who is to be the technical speaker at several of the meetings, will use as his general subject "Solving Problems in Materials." He has developed a technical address covering a number of interesting problems in different materials fields but related to the electrical manufacturing group. From the variety of problems he will select those case histories of most interest to the particular district where he is visiting.

It is hoped that each ASTM member and committee member in the different districts will note these meetings on their calendars and plan to be present. One of the major objectives is to have our people in the various districts meet Society officers who may be present, and particularly one another.

Executive Secretary on European Trip

THE Executive Secretary of the Society left on August 31 for a business trip to Europe that will take him to England, France, Belgium, Holland, Switzerland, and Sweden. Mr. Warwick will visit the heads of the national standards institutions, testing societies, and a number of technical associations in those countries with which the Society has maintained contacts and in some cases direct cooperative relationships for many years. He will discuss with them their activities in the fields of research and standardization and the corresponding activities of our own Society. He will also visit some of the leading research and testing laboratories abroad and call on various members of the Society in the countries visited.

Contacts with the institutions and associations visited—upward of 40 in number—include especially those dealing with ferrous and non-ferrous metals, petroleum, rubber, plastics, and textiles, in which fields increasing attention is being given to the international aspects of testing. Relations in all fields of materials between ASTM and the standards institutions abroad will be explored. A study will be

DISTRICT	DATE	PLACE	SUBJECT	SPEAKER
New England.....	October 9	Commander Hotel, Cambridge, Mass.	(1) "Industrial Applications of Radioactive Methods" (2) "Radioactive Techniques and Engineering for Radioisotopes"	(1) Professor John W. Irvine, Jr., Department of Chemistry, Massachusetts Institute of Technology (2) A. F. Rupp, Supt., Radioisotope Development Dept. Oak Ridge National Laboratory
Ohio Valley.....	October 10	University of Louisville, Louisville, Ky. Dinner plus technical program. Plant visits	"Solving Problems in Materials, Particularly Metals" (Jointly with American Society for Metals)	ASTM President Truman S. Fuller, Engineer in Charge, Works Laboratory, General Electric Co., Schenectady, N. Y.
Pittsburgh.....	October 23	Pittsburgh Dinner and Smoker	Informal remarks by President Fuller. Also Staff representative Entertainment and discussion	Informal comments by President and others
Western New York-Ontario.....	October 24	Hotel Sheraton, Buffalo, N. Y.	"Solving Problems in Materials"	ASTM President Truman S. Fuller
New York.....	October 26	Engineering Societies Bldg., New York, N. Y.	"Solving Problems in Materials" Sound-color film	ASTM President Truman S. Fuller
Northern California.	October 31	Engineers' Club, 206 Sansome St., San Francisco, Calif. Dinner and technical program	"Corrosion Testing and Engineering" (Jointly with National Association of Corrosion Engineers)	F. L. LaQue, in Charge of Corrosion, Engineering Section, Development and Research Division, The International Nickel Co., New York 5, N. Y.
St. Louis.....	November 1	Engineers' Club of St. Louis, 4359 Lindell Blvd., St. Louis, Mo.	"High Temperature Metals"	Past ASTM President, Dr. A. E. White, Director of Department of Engineering Research and Professor of Metallurgical Engineering, University of Michigan
Philadelphia.....	November 2	Hotel Traylor, Allentown, Pa. Dinner and plant visit	"Solving Problems in Materials, Particularly Metals" (Jointly with American Society for Metals) Coffee speaker: "Just Problems"	ASTM President Truman S. Fuller. A. O. Schaefer, Chairman, Philadelphia ASTM District, Vice-President in Charge of Engineering and Manufacturing, Midvale Co.
Southern California.	November 8	Rodger Young Auditorium, 936 W. Washington Blvd., Los Angeles, Calif.	"Corrosion Testing and Engineering" Joint meeting with several Southern California Sections	F. L. LaQue—See above

PUT THE ABOVE DATES ON YOUR CALENDAR AND PLAN TO BE PRESENT. EVERYONE CORDIALLY INVITED

made of the procedures and operations of the International Organization for Standardization (ISO) in which ASTM is interested by virtue of participation in certain international standardization projects, through the American Standards Association as the American member of ISO.

Since many of the institutions to be visited have been invited to be represented at the Society's Fiftieth Anniversary Meeting in New York City in June, 1952, the Executive Secretary will supplement the formal invitations with the assurance of our desire to have the representatives of these institutions participate appropriately in the Anniversary Meeting. Contribution of certain engineers and scientists to the technical program of that meeting will be discussed at the request of several of the ASTM committees.

Mr. Warwick will return November 1. During his absence the Assistant Executive Secretary of the Society, R. E. Hess, will be in charge of Society Headquarters.

ASTM 50 Years Ago

1. The first list of members was published. There were 168 members. (The present Year Book of 600 pages lists over 7000 members and over 300 pages of technical committee personnel. Growing pains!)

2. Prof. Henry M. Howe, chairman of the 4th Annual Meeting at Niagara Falls, N. Y., in 1901 began his address with: "In this weather, and with the attractions of the Pan-American Exposition competing, to inflict upon you a long address would be a poor return for the compliment you have paid me in calling me to preside over your deliberations." Apparently times haven't changed much, since the weather and competing events still plague ASTM Annual Meetings. In the course of his address he brought up one value of ASTM not often thought of today. He remarked, "We aim to unify the methods of testing materials of construction throughout the world, and thereby greatly facilitate our export of these materials, and thereby to offset the disadvantage of our relatively isolated geographical position.

3. Members of Committee A-2 may be interested in a bit of discussion preceding the adoption of "Specifications for Wrought Iron" at the 1901 meeting. The chairman of the committee pointed out that Section No. 1 of the Specifications would "exclude the greater part of the Swedish wrought iron, most of it being made by the charcoal-hearth process." After discussion it was ordered that the Section be amended by inserting the words "or out of pig iron by the knobbling process."

4. Chairman Howe, on behalf of the executive committee, reported that all American Members of the Association had been officially and cordially invited to attend the International Congress of 1901 to be held in "Budapest" on September 9–16.

5. The Secretary in his report stated that "Up to the present date the following dues have been received:

Dues for year 1899	*$ 6.50*
Dues for year 1900	*22.50*
Dues for year 1901	*316.00*
Dues for year 1902	*4.00*
Dues paid in excess	*.10*
	$349.10

(Total dues in 1951 Budget $208,000.00)

ASTM 25 Years Ago

1. The Charles B. Dudley Medal was established through contributions from the members, and the Edgar Marburg Lecture also was instituted. Over 1400 members of the Society subscribed various amounts to underwrite this Medal and the Lecture which commemorate two men who did so much to found ASTM.

2. Committee C-18 on Natural Building Stones was organized.

3. Student Membership was established. At the time the dues were $3, but the student got a copy of the Book of Standards, the BULLETIN, etc. Now the dues are $2, with a number of distinct advantages.

4. Total number of ASTM Standards and Tentatives was 500.

5. For the first time the Society's total annual receipts exceeded $100,000. (Current budget is upward of $600,000.)

6. One of these "fateful" or "fearful" questionnaires was taken on location for the 1927 Annual Meeting. Atlantic City led, with French Lick Springs in second place, and the Lake Placid Club third. Sixty members wanted to go to Asbury Park. (We must have worked them pretty hard at the time, and they perhaps wanted rest.)

During July and August the Channel Gardens at Rockefeller Center are transformed into a cool mid-Manhattan oasis with the installation of the annual aquatic garden display. Water lilies, colorful caladiums, water hyacinths, and hundreds of goldfish decorate the pools and planting areas of the unique garden, which extends from Fifth Avenue to the Lower Plaza. In the background is the famed Prometheus Fountain and the main entrance to the 70-story RCA Building. The flags of the United Nations fly briskly along Rockefeller Plaza.

A Few Facts About Rockefeller Center:

There are page after page of interesting facts and statistics. Here are a few. You may dine in any of 26 restaurants, and shop in more than 200 stores which sell everything from oranges to oriental antiques. The Center has its own Post Office, a passport bureau, four drugstores, ten banks, four barber shops, a florist, six schools (from golf to languages), dozens of dentists, a dispensary, a pet shop, telegraph and cable services, opticians, a toy store, and even chiropodists.

The consulates of twenty foreign nations are located in the Center, as are the offices of eleven airlines, almost a score of railroad lines, and thirty-six travel and information bureaus. Here is the home of The Associated Press, largest news gathering agency in the world, and two of America's greatest networks, the National Broadcasting Company and the American Broadcasting Company. The editorial offices of dozens of magazines, including *Time, Life,* and the *Ladies Home Journal* are located in Rockefeller Center, as are the offices of several important book publishers. Leading firms and associations in the fields of rubber insurance, diamonds, oil, tobacco, chemicals and advertising are included on the tenant list, which establishes the Center as one of the key points in the world of commerce.

Standardization Activities of Technical Committees

Standardization Projects Being Pushed

In the September issues of the last two years, and before that in the August issues of the BULLETINS, there has been given a "round-up" of important standardization activities under way in the various technical committees. Again this year, the activity reports which follow are a "look-ahead" and should provide some conception of the tasks set up and already in progress. The information is based in part on current reports of the technical committees and also in large measure on committee work programs sent in to Headquarters by the various officers. Much of this information is of interest to the membership broadly, and is also a great help to the Administrative Committee on Standards and the Staff.

Arrangement of Material

The material which follows is arranged in the order of the designations of the technical committees; for instance, the "A" and "B" groups appearing first, followed by the "C," "D," and "E" groups.

Ferrous and Non-Ferrous Metals "A" and "B" Committees (see also "E" Groups)

A-5 Corrosion of Iron and Steel

CONTINUING its study of physical tests, Committee A-5 is considering changes in several methods to permit the use of square, rectangular, or circular test specimens and to remove from these methods of test, specific instructions concerning the locations from which the test specimens are to be taken. The study on the reactions of various coatings (hot-dipped, electrodeposited, heat-treated, etc.) in copper sulfate solutions is continuing.

A new tentative specification for 1.25-oz zinc-coated iron or steel roofing sheets has been prepared and proposed changes in the Tentative Specifications for Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils and Cut Lengths (A 93 – 50 T) in the bend test, sheet weight test, and ordered weight of coating are being considered. The desirability of adding an additional grade to Tentative Specifications for Zinc-Coated (Galvanized) High Tensile Strength Steel Telephone and Telegraph Line Wire (A 326 – 49 T) is being studied.

Revisions of Standard Specifications for Zinc (Hot-Galvanized) Coatings on Structural Steel Shapes, Plates and Bars, and Their Products (A 123 – 47) and of Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware (A 153 – 49) are being considered in order to clarify the use of these two specifications in so far as small structural shapes commonly called bar sizes, bolts, and washers are concerned. These will eliminate the uncertainty which exists at present as to which one of these specifications is the proper one for these "borderline" items.

A-6 Magnetic Properties

COMMITTEE A-6 is engaged in rewriting several sections of the series of standards included in A 34 – 49 T, Methods of Testing Magnetic Materials. The revisions in A 34 are planned to be ready for the 1952 Book of ASTM Standards and may be summarized as follows:

1. The use of smaller samples to reduce testing cost.
2. Improved test accuracy by better provision for air flux.
3. Replacement of the undefined term "feebly magnetic" with a statement of permeability values for which the test method is suitable.
4. Increase of the standard value from 10 gausses to 20 gausses in the low-induction test.

In addition, the committee is compiling data on the properties of magnetic materials to include the average and range for various properties of widely used magnetic metals to provide information for designers and technical men.

A specification is being developed for each of the more important magnetic materials to standardize on those requirements on which agreement can be reached.

In addition to the above specification work, the committee expects to issue a separate technical publication in the nature of a manual of magnetic testing.

A-10 Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys

CONTINUING its valuable contributions in the field of corrosion- and heat-resisting steels, Committee A-10 is at the present time preparing a recommended practice for cleaning of stainless steel surfaces, particularly in connection with fabricated equipment. Another specification under consideration is that for stainless steel strand wire.

A special subgroup has collected data on the effect of substituting columbium-tantalum for ferro-columbium in columbium-bearing steels and as a result of this work, Committee A-10 will recommend through the Administrative Committee on Standards, revision of all specifications under its jurisdiction containing columbium-bearing grades of stainless steel to permit the use of the columbium-tantalum alloys. These revisions will be in the form of Emergency Alternate recommendations.

Work has been initiated and is continuing in the formulation of specifications for centrifugally cast-iron alloy tubing for heat and corrosion-resisting service. Revisions are being considered in A 262 – 44 T, Tentative Recommended Practice for Boiling Nitric Acid Test for Corrosion-Resisting Steels which include (*a*) the addition of a footnote suggesting metallographic examination of specimens that have suffered a high weight loss in the test to establish whether intergranular attack has actually occurred, (*b*) an amendment to permit use of multiple sample testing apparatus, and (*c*) the use of a Nylon brush as an alternate to rubber in cleaning specimens after exposure to the acid.

B-2 Non-Ferrous Metals and Alloys

COMMITTEE B-2 on Non-Ferrous Metals and Alloys is quite active at the present time developing specifications for two additional materials, namely, tin and titanium. Specification work on titanium may result in three specifications: (1) iodide titanium, (2) commercially pure titanium ingot metal, and (3) commercially pure titanium sheet, strip, wire, bar, rod, plate, and tubing.

The revision of Specifications B 6 – 49 (slab zinc), in connection with the use of the word "none" when used to designate the amount of impurity, is continuing. The study which has been in progress for the past two years is still continuing on methods of test for continuity of coating of lead-coated copper sheet (B 101 – 40).

B-4 Electrical Heating, Resistance, and Related Alloys

SPECIFICATIONS B 82 – 46 and B 83 – 46 concerning alloys drawn or rolled for electrical heating elements are undergoing re-examination, particularly on the basis of the controls of wire sizes and resistance.

Modifications of thickness-width ratios as specified in the Standard Method of Testing Thermostat Metals (B 106 – 40) to coincide more exactly with standard test samples commonly used in the industry

are under consideration. The committee is also concerning itself with test methods and specifications for Invar and related low expansivity alloys. The current work of Subcommittee X on Contact Materials includes life tests, improved methods of determining surety of making contact, and the effect of oxidation and sulfidation treatment on contacts. In addition a new section has been formed on Micro-Current Contacts.

Several methods for small sample chemical anslysis of cathode "impurities" have been approved in cooperation with Committee E-3 and when others are completed, a broad specification will be set forth.

In 1943 this subcommittee compiled a "Bibliography on Electrical Contacts." Periodically thereafter paper-bound supplements were issued. As a result of continuing interest in the original book and decreasing interest in each succeeding supplement (there now being six supplements), the subcommittee has decided to concentrate on a revised edition of the book to include all supplementary references up to and including 1950. This publication should be available in the Fall.

B-6 Die-Cast Metals and Alloys

COMMITTEE B-6 on Die-Cast Metals and Alloys has established a task group to set up limits for impurities generally found in die castings and which are not at present covered in the Standard Specifications for Zinc-Base Alloy Die Castings (B 86 – 48).

Consideration is being given to the adoption of the Frankford Arsenal code identification system for alloys with the following in mind: (1) adoption of the code system without change for the aluminum alloys and (2) adoption of the code for the zinc alloys using both the old and new system numbers concurrently.

B-7 Light Metals and Alloys, Cast and Wrought

COMMITTEE B-7 on Light Metals and Alloys is developing a comprehensive table setting forth a realistic evaluation of the relations between various properties for a number of sand and permanent mold casting alloys. The recommended practice for both alloy and temper codification of light metals and alloys is rapidly approaching its final form.

The corrosion program of Committee B-7 involving riveted and various other types of test specimens of aluminum and magnesium alloys is progressing satisfactorily. Collection of the samples has been completed and as soon as the details of fabrication have been completed, the specimens will be put on exposure.

B-8 Electrodeposited Metallic Coatings

ALTHOUGH under discussion for some time, no decision has been reached as to the advisability of including metric equivalent for thickness in the text of specifications under the jurisdiction of Committee B-8 and this problem is still under consideration.

The committee is active in many fields and reports progress in the study of thickness tests, porosity tests, mechanical property tests, and luster tests. A new specification is currently being developed on the preparation of copper and copper alloys for electroplating. A survey is also being made to determine the desirability of preparing a procedure for the preparation of plastics for electroplating. Future specification work may include recommended practices for the preparation of malleable and cast iron, and lead and lead alloys for electroplating.

Study is continuing on the correlation between outdoor exposure and accelerated tests on several types of chromate films applied to electrodeposited zinc on steel. Substantial preliminary work has been done on the evaluation of supplemental chromate treatments of cadmium plate.

Progress has been made on a rather extensive testing program in which steel panels zinc-plated, sulfate-treated, and coated with a clear alkyd varnish will be subjected to various accelerated tests as well as atmospheric exposure. Variables will be acid and cyanide zinc and thickness of sulfate coating.

Cementitious, Ceramic, Concrete and Masonry Materials—"C" Committees

C-1 Cement

THE subcommittees of Committee C-1 responsible for the preparation of specifications have before them as current projects suggested revisions of requirements for setting time and fineness of portland cement and a revision of the limitations for sulfur trioxide which will provide for the use of the optimum sulfur trioxide content in a given cement. A project in connection with the test methods included in the Specification for Masonry Cement (C 91) is one of considering revisions in the apparatus requirements, with special consideration of mechanical mixing of mortars. The major project in respect to blended cement is the continuation and expected completion of a series of tests by five laboratories on twenty samples of fly ash for the purpose of evaluating proposed specifications, both for fly ash and for portland-fly ash cement.

The tabulation of long-time data on cements subjected to autoclave tests and of tests for length change in storage in water and in air are nearing completion. The completion of a second series of cooperative tests on lean mortar bars made by seventeen cooperating laboratories is also expected during the coming year. Data is being collected through a cooperative test program on certain proposed modifications of the standard test of heat of hydration of portland cement. Means of measuring the plasticity of cement pastes and mortars are being studied for possible changes in the tentative method of test for bleeding of cement and pastes and mortars. The preparation of a new test method for determining flexural strength of mortar is expected to be completed by the time of the Fall Meeting of the Committee.

Producer members of the committee have been urged to determine for their own cements the optimum SO_3 content by adding gypsum in small increments and testing the resulting products for strength and volume constancy. A report is expected at the fall meeting on an extensive series of cooperative tests by eleven laboratories now studying important questions that are involved in measuring the air-entraining properties of cements.

C-2 Magnesium Oxychloride and Magnesium Oxysulfate Cements

A PROPOSED method for determining shear strength of bonding media for magnesium oxychloride cements has been developed, but recommendation for acceptance is being held in obeyance pending further test data which will be collected during this coming year. A subject which will be studied is the need for a long-range soundness test. Work is being done on an improvement in the current mechanical mixing method used in testing oxychloride cements due to the fact that the present method induces air entrainment, resulting in false load strengths, when softwood sawdust is used in the mixes.

C-3 Chemical Resistant Mortars

THE committee is writing specifications with the necessary test methods required for several types of chemical-resistant mortars. A specification for silicate mortars is nearing completion. Test methods have been completed for determining tensile and compressive strength of resin mortars, and consideration is now being given to procedures for measuring setting time, working time, bond strength, water absorption, and chemical resistance. A specification for sulfur mortars is now being drafted in final form for recommendation to the committee at its next meeting.

C-4 Clay Pipe

THE two major standardization projects which will occupy the attention of Committee C-4 during the next year will be a study of the possibility of combining the several ASTM specifications on clay pipe into one, or as an alternative to this, the separation of the test procedures, which is now common to all of the specifications, into a separate ASTM standard. The second project is that of the development of specifications for clay flue linings.

C-7 Lime

Two additional specifications will be developed by Committee C-7 for the use of lime in the chemical indus-

tries. Study will be given to the use of lime in silica brick and in leather tanning. Attention is being given toward a new method of test for iron determinations in lime and limestone, which is faster and more reproducible than existing methods. A new method of determining available lime, developed at the Massachusetts Institute of Technology, will be studied. Research is still under way on a new lime slaking test.

C-8 Refractories

In addition to the industrial surveys now being included in the 1951 edition of the C-8 Manual, in the process of being printed, it is hoped to prepare surveys on reheating and annealing furnaces, paper industry, frit smelters, soaking pits, and the zinc industry. These industrial surveys provide additional information on the use and service conditions of refractory materials for which ASTM Standards have been developed. Data will be gathered to establish the usefulness and limitations of sonic testing of refractories. A section is reviewing the procedures for high-alumina refractories and is considering a method for the determination of sulfur in insulating refractories. The effect of the rate of load application on the measured strength of refractory insulators and insulating refractories is being examined in three member laboratories. Comparative study of methods now in use for measuring bulk density of calcined materials has been initiated. A panel refractoriness test will be reported upon at the next meeting of the committee.

The Subcommittee on Special Refractories has outlined a plan for research in the development of certain tests such as reheat (high-temperature shrinkage), high-temperature load test, spalling test, and slag test. This project will involve the solicitation of funds from the refractories industry and is expected to cover a period from three to five years. In order to cover the testing of carbon refractories, several existing standard test methods will be reviewed for possible revision, which will make them adaptable to use with this type of refractory material.

C-9 Concrete and Concrete Aggregates

Group II on Research has many projects under way in its subcommittees. Among these are cooperative tests on abrasion test methods, which will include the cutting, rubbing or sliding, and ball types; exploratory tests, using three types of apparatus for determining various setting times, to establish data on desirable properties to measure in concrete; and the review of a method for petrographic examination of mineral aggregates.

In Group III on Specifications and Test Methods, the subcommittee projects include the preparation of a tentative specification covering paper molds; a revision of the current Method of Sampling Fresh Concrete (C 172); a consolidation of the various methods for measuring the air content of freshly mixed concrete; a review of existing standards and the development of new test methods for use in evaluating admixtures; and further round-robin testing to confirm the reproducibility of the Tentative Method of Test for Bleeding of Concrete (C 232 T). The final draft of a complete revision of the Standard Specifications for Lightweight Aggregates for Concrete (C 130) will be circulated for letter ballot, and the first draft of a specification and a method of test for fly ash is expected to be completed by the time of the fall meeting of the committee.

Three new subcommittees, created during the past year, will be concerned with methods of testing concrete for resistance to abrasion, methods of testing setting time of concrete, and methods of testing concrete for resistance to freezing and thawing. Further details of the work of the first two subcommittees has already been mentioned earlier in this article.

C-11 Gypsum

Committee C-11 membership has been enlarged to include representatives manufacturing and using lightweight aggregates and sand, and subcommittees are working on research data pertaining to the compressive strength of plaster mixed with sand and lightweight aggregates, both on a volume basis. The methods of filling molds in the Standard Methods of Testing Gypsum and Gypsum Products (C 26) are being studied. A subcommittee is studying a suggested revision to the sand gradation in Standard Specifications for Gypsum Plasters (C 28).

C-12 Mortars for Unit Masonry

Revisions of the Specification for Aggregate for Masonry Mortar (C 144) are being drafted for acceptance at the next meeting of the committee. Final arrangements have been made for setting up a program of tests to determine the efflorescence tendencies of mortars.

C-13 Concrete Pipe

Committee C-13, having completed several minor revisions of existing ASTM specifications for concrete pipe, has now set up various projects of a more long-range nature. Items to be studied include: the use of cores for testing the compressive strength in concrete pipe, correlation of wording between the several ASTM specifications, correlation of the steel sizes in Specifications C 75 and C 76, correlation of the test loads and the required steel in these two specifications, and the study and possible revision of the ratio between the 0.01-in. crack and the ultimate failure point in Specification C 76. A subcommittee has been formed to study the absorption test requirements.

Two projects, dealing with the development of new standards, have been authorized, these being the preparation of a recommended practice for bedding and backfilling of concrete pipe lines and the preparation of specification for reinforced concrete low-head pressure pipe.

C-14 Glass and Glass Products

The development of a routine method for the determination of boron in glass is still incomplete and work is continuing. Another project in chemical analysis is a cooperative project with Committee C-7 on Lime on a method of determination of iron in limestone. Several cooperating laboratories are conducting tests using the ASTM Methods of Test for Resistance of Glass Containers to Chemical Attack (C 225 – 49 T) to establish its reproducibility. It has been recommended that a group be formed to study expansion, softening, strain, and annealing point methods. A problem now being considered is that of establishing a supply of glass disks for use in connection with the ASTM Method of Polariscopic Examination of Glass Containers (C 148 – 50). Work on the development of an abrasion test for flat glass has been temporarily suspended, pending results obtained in ASTM Committee D-20 on Plastics.

C-15 Manufactured Masonry Units

A subject of considerable interest, namely that of a comparison of various types of materials used in capping concrete masonry units for testing purposes, will be investigated during the coming year. Comparisons will be made between the present ASTM capping method using portland cement and calcined gypsum, with sulfur capping material. Revisions in details of the specifications for structural clay tile units will be considered by the proper subcommittee.

C-16 Thermal Insulating Materials

In the field of block and pipe insulation, Committee C-16 has current projects under way for development of test methods dealing with thermal conductivity and resistance to vibration. A proposed method for determining moisture absorption for preformed block and pipe insulation is being redrafted. Several proposed specifications are now being prepared on specific types of block and pipe insulation such as cellular asbestos-paper pipe insulation, corkboard, cellular glass block, lime-silica block insulation, magnesia block and diatomaceous earth. The Subcommittee on Structural Insulating Board has various test methods under consideration, one being a flame resistance test. The subcommittee is also interested in tests for determining rigidity, moisture resistance, and linear expansion. Cooperative evaluation of a new plasticity test on insulating cements is being made to establish the performance of this test method. A proposed tentative method of test for adhesion of dried thermal insulating cement is being rewritten for further consideration. Test data was being solicited on a proposed density test method of loose fill.

The Subcommittee on Thermal Conductivity is currently considering revisions of the guarded hot box test method (C 236 – 49 T), and a survey is being made of all current users of this type of apparatus. In considering special thermal properties, a second round-robin series of tests with eight laboratories participating is underway to determine specific heat on a lime-

silica sample. The preparation of a method for establishing the maximum high-temperature limit of high-temperature insulation is nearing completion. Preliminary discussion has been under way on a proposed method for measuring emissivity. Producer members of the committee are being circulated for comment on proposed recommended dimensional clearances between pipe and tubing and cut, formed, or molded pipe insulations.

A proposed method of test for water vapor transmission of materials greater than ½-in. thickness is nearing completion. A study is continuing on methods to measure water vapor transmission of built-up sections and on transmission limits of vapor barriers for industrial application.

C-17 Asbestos-Cement Products

IT IS expected that a proposed specification for asbestos-cement pressure pipe will be completed during the coming year. In respect to the existing specification for flat sheets, a study of the values now used for breaking loads and deflection and for water absorption will be completed and will lead to recommended revisions. A task group is collecting data, which will be presented to the members, on which to base a decision as to the best method for testing asbestos-cement products with reference to wet strength and water absorption. Methods are also being considered for a flexibility test for type III flat sheets.

C-18 Natural Building Stones

A SUBJECT of considerable interest to Committee C-18 is one of nomenclature applying to such terms as grain size and texture. There has been a long-felt need for standardization of these terms throughout the industry. There has also been a need for a definition of just what constitutes a polished, a honed, and other types of finish on natural building stones.

A series of cooperative tests are being made during the coming year on samples of roofing slate for the purpose of establishing date on which to base a specification.

Close coordination will be established with a current research project now being conducted at Mellon Institute under the sponsorship of the National Association of Marble Producers. It is hoped to establish from this work needed testing procedures on exterior marble. Data from this research program will also be studied in connection with a proposed specification for exterior marble. The committee has been approached with the request to prepare a specification for limestone as a building material. The industry will be circularized and consulted as a preliminary step in this direction.

C-19 Structural Sandwich Constructions

THE coming year should see the completion of several methods of tests which Committee C-19 has been developing during the past two years or more. In addition to several proposed methods now completed and recommended for adoption by the Society, it is expected that additional methods will be completed during the year on mechanical properties of basic materials including dimensional stability, thermal expansion, and bondability. Test methods dealing with the mechanical properties of the basic sandwich construction, which have been developed and are now being prepared for recommendation to the Society, include a tension and a bending flatwise test. The committee is interested in developing an outdoor exposure test cubicle design in order to establish data on permanence, durability, and simulated service.

C-20 Acoustical Materials

COMMITTEE C-20 is fast approaching the point when definite recommendations can be made in the establishment of ASTM standards in this field. The basic property of sound absorption is being studied through the use of three types of testing equipment, namely, the reverberation chamber, box, and impedance tube. It is expected that a method of test will be written using the impedance tube during the coming year. Other basic physical properties are receiving attention with round-robin tests being run on a flow-resistance method. A method for measuring light reflection is being reviewed, and a draft has been prepared on strength test methods, which will then be used to obtain test data. The problems of application and maintenance are closely related to the measurement of basic properties of acoustical materials, and considerable research is planned on these factors. A suitable fire-resistance test is being considered and a subcommittee is investigating improvements in the Columbia or Panel Test method described in Federal Specifications.

C-21 Ceramic Whiteware

A VERY difficult task of preparing definitions of terms in the ceramic whiteware field is gradually being completed through the diligent efforts of the Subcommittee on Nomenclature. In respect to test methods, a section on raw materials has under consideration the development of methods for sieve analysis and water content, chemical analysis, sampling, and shrinkage of clays. A rapid, as well as an umpire, method for chemical analysis of feldspar, flint, talc, pyrophyllite, and nepheline syenite is under development. There is also considerable activity in the development of test methods on ceramic whiteware products which include proposed test methods for true specific gravity, linear thermal expansion, modulus of rupture of dry-pressed products, and an absorption test.

C-22 Porcelain Enamel

COMMITTEE C-22 has now presented its first tentative methods of test to the Society, these being methods of test for: Resistance of Porcelain Enameled Utensils to Boiling Acid, Impact Resistance of Porcelain Enameled Utensils, Sieve Analysis of Wet Milled and Dry Milled Porcelain Enamel, and Acid Resistance of Porcelain Enamels (Room Temperature Test).

Additional investigations are being carried on concerning rapid sieve-testing methods of satisfactory reproducibility and the particle size analysis of subsieve fractions of milled porcelain enamels. Considerable progress has been made toward the preparation of additional methods of testing raw materials such as fusability of enamel frits, consistency of enamel slip, and the evaluation of enameling iron. The effect of the composition of water used in the milling of porcelain enamels upon the characteristics of the resultant porcelain enamel slip is also under study.

Proposed test methods dealing with finished products are under preparation and they include tests for warpage, resistance to abrasion, and reflectance of porcelain enamel coatings.

Miscellaneous Materials—"D" Committees

D-4 Road and Paving Materials

Two subcommittees of Committee D-4 are planning to cooperate in the development of compressive strength tests for mixtures comprising liquid asphaltic materials and the effect of water on such compressed mixtures. These cooperative tests will be made using methods for the preparation of test specimens to be subjected to various types of strength tests including the use of a proposed method for the determination of specific gravity of compressed bituminou mixtures. In considering other physical tests for compressed bituminous mixtures, the development of standardized strength tests including triaxial compression and the Marshall test, will be studied. The reproducibility of the present Tentative method of Test for Effect of Water on Cohesion of Compacted Bituminous Mixtures (D 1075 T) will be investigated.

A series of cooperative tests to obtain data on the precision of the revised Standard Method of Test for Distillation of Tar Products Suitable for Road Treatment (D 20) are planned. Efforts are continuing to develop a satisfactory method which will replace the two present methods for ring-and-ball softening point determinations, in cooperation with Committee E-1. The reproducibility of the Engler specific viscosity test is being checked through cooperative tests. An investigation of methods for determining the specific gravity of aggregates is being made, which will have direct significance in the control and design of paving mixtures. The setting time for types of bituminous materials has received attention through a series of tests, and a new tentative method

is to be recommended. Cooperative tests to establish a procedure for determination of viscosity of emulsified asphalts at 122 F are in process.

Additional specifications and recommended practices are planned applicable to surface treatment of highways. A special subcommittee has been organized to study suggestions for improvement of the pycnometer requirements as specified in the Standard Method of Test for Specific Gravity (D 70). Work is continuing on research in the form of cooperative tests to measure the adhesion of bituminous films to mineral aggregates and the resistance of these films to "stripping."

D-6 Paper and Paper Products

NEW test methods being developed in Committee D-6 will include the measurement of such properties and factors as erasability, moisture expansivity, gloss, pinholes, color fastness to light, and zinc and cadmium pigments. Revisions are being studied on several of the existing ASTM standards on paper and paper products. The subcommittee dealing with container board is currently working on test methods to measure flat crush, immersion number, and wet bursting properties.

In the field of specifications, a subcommittee is working on a specification for kraft paper for multi-wall bags.

D-7 Wood

A REVISION of the Standard Specifications for Round Timber Piles (D 25) is expected to be completed during the coming year. Some changes may be made in the Tentative Methods for Establishing Structural Grades of Lumber (D 245 T) as a result of further study now under way on the basic principles of structural grading.

Research has continued on the improvement of a tension-parallel-to-grain test specimen as a modification of this test in Standard Methods of Testing Small Clear Specimens of Wood (D 143). The modified specimen that has given promising results is loaded by shear through notched supports at the ends instead of wedge grips. By eliminating slippage at the grips, the time of test is materially reduced, while satisfactory failure in the reduced section is still obtained.

Coordination with AREA is being continued to secure data on experience and classification of exposures with respect to requirements for fire-retardant treatments. It is hoped that satisfactory classification can be established in the near future.

A series of methods for the complete chemical analysis on wood have been developed and accepted by the Society. Additional methods are now in preparation.

Plans are now being more firmly developed for a proposed wood pole testing program, which will attempt to establish standard methods of test, and strength data relating to specifications for treated and untreated wood poles of various species.

D-8 Bituminous Waterproofing and Roofing Materials

PROPOSED methods of tests and specifications for insulating siding are nearing completion in Committee D-8. A task group is studying the development of a proposed "Blistering Test." The development of a specification for burlap saturated with asphalt is receiving study by a task group and a test program is being set up. Work groups on consistency measurements report definite and encouraging progress with data and methods available for appraisal and criticism.

Roofing and waterproofing asphalts are being studied in respect to the need of a constant-load type of cold flow test at low temperatures, low rate of shear, and the measuring of small deformations. Self-healing ability is also to receive consideration. A new method for the preparation of panels for the accelerated weathering test is being considered. A second cooperative series of tests is being conducted on compatibility of asphalts and a series of tests will be conducted to establish reproducibility.

Further cooperative studies are in process to improve the cigaret paper method for measuring the relative staining qualities of industrial type asphalts as agreement among laboratories has not been satisfactory due possibly to difficulties in reading the stain.

D-10 Shipping Containers

AN ADDITIONAL group of definitions of terms are being given a final review, these terms applying to interior packing. The need for further study of vibration and its effects upon shipping containers has been made evident, and this will be pursued during the coming year with possible revisions being recommended to the existing test method. Definite progress has been made in the development of a mutiwall bag puncture test. Two new test cycles will be carried on for measuring water vapor permeability of packages and shipping containers.

Considerable attention in the committee is now given to performance standards, and one of the current projects is a review of the National Safe Transit tests with the purpose of possible adoption as performance specifications. The correlation of tests and test results is proving of considerable interest and value. With the completion of round-robin tests on corrugated boxes, using the revolving drum test, and another using the compression test, a new series of drop tests followed by tests on the incline impact apparatus are being instigated. The committee is attempting to discover possible correlation between various laboratories and various test methods.

An important phase of the committee activity is in the study of interior packing, and, at the present, test methods for evaluating cushioning materials, including shock absorption, abrasiveness, and surface protection are being made.

D-12 Soaps and Other Detergents

COMMITTEE D-12 is continuing work, in cooperation with the American Oil Chemists Society, on methods for determining water-insoluble matter, borax, and copper in soap. Methods for analysis of sodium bicarbonate are still under development. Current work relating to metal cleaners includes a procedure for evaluation of emulsification properties and a recommended outline for soil removal procedures for evaluation of metal cleaners. Specifications for sodium orthosilicate and for caustic potash are being prepared.

D-14 Adhesives

IN THE study of strength properties of adhesives by Committee D-14, a new simplified method for determining the tensile strength of wood adhesives is being considered to supplement that in D 897. The development of a method for determining the single-lap shear strength of bonded plastic specimens is requiring the investigation of specimens with overlap of 0.5 in. and less. Other properties being studied include a method for measuring creep and cold flow of thermosetting adhesives. Five proposed methods for determining the solids content of urea adhesives are being investigated.

The work on the effects of cyclic exposure to variations in moisture and temperature on the strength of bonded metal and plastic specimens is being continued. Three additional methods are being written to determine the effect of biological factors on adhesives. A program is being organized to utilize the exposure test sites under the jurisdiction of the Advisory Committee on Corrosion to test adhesives. Additional procedures for determining consistency are being studied for possible inclusion in D 1084. A round-robin testing program with the modified Green Tackmeter is under way. A new method for determining storage and working life is being developed. A method is being prepared for determining the power factor, dielectric constant, dielectric strength, insulation resistance, and arc resistance of cured solid adhesives and of liquid adhesives which are to be cured by dielectric heating.

Specifications are being written for general utility, acoustical, bookbinding packaging, and wood adhesives.

D-18 Soils for Engineering Purposes

THE SCOPE of Committee D-18 encompasses a wide field as indicated by the projects of the different subcommittees. The very nature of this work involves considerable research and pioneering at this time in the development of test methods. As a result, Committee D-18 has sponsored several symposiums, which have been presented on such subjects as triaxial loading, soil classification, and surface and subsurface reconnaissance. In the field of actual test methods, two are being reviewed at present, one covering borings and sampling for soil investigation

of embankment material, and another being the split-spoon and thin wall tube sampling methods of soils. Revisions are being considered on several of the existing physical and mechanical test methods of soils.

A phase receiving considerable attention at the present is that of the development of procedures measuring physicochemical properties of soils. Initial plans and procedures have been submitted for subcommittee study on a complete chemical analysis of soils, a petrographic analysis of soils, and the preparation of hydrogen clays in quantity for laboratory use.

Characteristic dynamic properties of soils being studied are elasticity, damping, stand and propagation waves, consolidation, settlement, densification and bedding values, under dynamic loads, with or without static surcharges, and resonance phenomena of the vibratory systems. Several joint research projects, being carried out by other agencies, are being followed. Three tentative methods of test for plate loading have been prepared for review by the committee.

D-19 Industrial Water

A MAJOR project nearing completion in Committee D-19 is the preparation of a Manual on Industrial Water. Several new and revised tentatives will be submitted to the Administrative Committee on Standards in the near future, while a large number of new and revised methods are currently being developed,, as covered in detail in the July BULLETIN under "Committee Notes."

D-21 Wax Polishes and Related Materials

A DETAILED account of the program of work of Committee D-21 in its standardization activities will be found in the recent July issue of the ASTM BULLETIN.

Miscellaneous Subjects—"E" Committees

E-1 Methods of Testing

(This statement covers work which was reported at the 1951 annual meeting, as well as important activities which are under way.)

COMMITTEE E-1 on Methods of Testing has been especially active during the year. It has organized a new Task Group on Porous Filtering Bodies, to give consideration to performance tests for these types of filterware made of sintered glass, stainless steel, ceramic ware, etc. A new Task Group on Shear and Torsion Tests is developing a program of work on these two important mechanical tests.

During the annual meeting there was a meeting of a Study Group on Cupping Tests which gave consideration to the need for undertaking work on tests for evaluating deep-drawing and forming properties of metals.

The work of the Subcommittee on Thickness Measurement is being reactivated and is cooperating with Committee B-4 in consideration of thickness test procedures for certain cathode ray and radio tube parts.

Committee E-1 is planning to sponsor a Symposium on Light Microscopy to be held at the 1952 Annual Meeting of the Society.

In its report, the committee presented to the Society Revised Methods of Tension Testing of Metallic Materials (E 8 – 51 T) which resulted from study by a Task Group over the past two years. The revised methods incorporated new procedures for testing steel spring wire and copper rods and bars, in addition to the procedures covered by the former Standard Methods E 8. Further study is being made of other features of the Methods which may result in revision next year. Revisions were also presented in the Tentative Methods of Compression Testing of Metallic Materials in Other Than Sheet Form (E 9 – 49 T) and Method of Compression Testing of Metallic Materials in Sheet Form (E 78 – 49 T).

An important revision of the Tentative Method of Tests for Softening Point by Ring and Ball Apparatus (E 28 – 51 T) makes provision for stirring the bath during the test. This change as well as other revisions in the Method were the result of a round-robin test made in cooperation with Committee D-4 on Road Materials and Committee D-1 on Paint Materials.

A number of important changes were also made in the Standard Specifications for ASTM Thermometers (E 1 – 50) which will improve the manufacturing details of these mercury-in-glass thermometers.

Committee E-1 will present to the Society during the summer a new Standard Hardness Conversion Table for Nickel and High-Nickel Alloys and also a new Tentative Method of Test for Diamond Pyramid Hardness of Metallic Materials. The latter was developed in cooperation with Committee E-4 on Metallography.

A final draft of proposed methods for making a three-edge-bearing test of pipe is now under review by the Subcommittee on Flexure Test. These methods are suitable for testing circular pipe and drain tile of concrete or clay, and cast iron culvert pipe.

Study is being made of laboratory ovens by a Task Group of the Subcommittee on Metalware and Laboratory Apparatus. This subcommittee has been very active and prepared some important changes in the Tag and Pensky-Martin's Flash Testers which are being adopted by Committee D-2.

The Task Group on Low-Temperature Testing of Elastomers and Plastics reported on results of a questionnaire sent to industry, government, and research centers which indicated that of the 100 tests reported upon, the four most generally used for evaluating materials for low-temperature service are stiffness, brittleness, hardness and rheological properties.

E-2 Emission Spectroscopy

SEVERAL tentative methods for emission spectrochemical analysis will probably be completed during the coming year. After several years of work in compiling suggested methods, which represent procedures currently found satisfactory by their submitters, the committee has reached the point where tentative methods can again be written, and methods applicable to aluminum, lead, tin, and zinc have been nearly completed. It is expected that the compilation of suggested methods mentioned above will be available late this year or early next year.

E-3 Chemical Analysis of Metals

IN ADDITION to work on a number of new and revised procedures that are intended to keep up to date the methods already published under its jurisdiction, Committee E-3 is currently developing methods for the chemical analysis of beryllium-copper alloys, titanium and its alloys, high nickel-chromium alloys, and electronic nickel. Work is continuing on methods for determinations of small amounts of aluminum in various metals and alloys. A revised bibliography on photometric methods for chemical analysis of metals will soon be completed.

E-5 Fire Tests of Materials and Construction

COMMITTEE E-5 has been requested by Committee E-6 to prepare a fire test method for small panels of construction materials, primarily for use of manufacturers in exploring the relative merits of various types of construction prior to their testing in accordance with the present ASTM Standard E-119. Preparation of such a test method has been given consideration by a subcommittee who have recommended to the main committee that E-5 and E-6 cooperate in the development of a recommendation for an exploratory test, defining limitation of size of specimen, stability, and other pertinent factors, and that a procedure be explored by which the small-scale fire test might be included in E-119. If these small-scale tests become ASTM standards, the results obtained from their use can, and probably will, be interpreted as indicative of the fire-resistance rating of materials, which is now determined by ASTM Standard E-119 and Tentative E-84. Since the subcommittee action, the complications that could arise from having two different test methods as ASTM Standards and which could easily be confused with each other have been reviewed carefully by the Advisory Subcommittee. As a result of this study, the Advisory Subcommittee has devised a proposal which will avoid confusion and serve the purpose of the small-scale test. This proposal has been submitted to the ASTM Headquarters for a policy decision.

At the request of the Joint Committee on the Unification of Building Codes, the

advisability of preparing a hose stream specification for application to constructions having fire-resistance ratings less than one hour is under consideration. Study is likewise being given to a revision of fire test specification E-119 to include suitable requirements for the conditioning of materials prior to fire testing and the performance requirements pertaining to temperature transmission of roof constructions.

There is a decided need for fire-test methods for fire-retardant paints and similar materials and the preparation of such a test method will be undertaken. The Method of Fire Tests of Door Assemblies (E-152) is being reviewed in its entirety for the purpose of including improvements which have been made in fire-test procedures, such as the evaluation of test results for obtaining a fire-resistance rating of doors, changes in the existing specifications which permit acceptance of similar doors having areas 25 per cent larger than those tested, permissible temperature limits on the unexposed surface of doors which would be used in locations where transmitted heat is a factor, and changes in the existing specifications with respect to hose stream requirements.

Research and investigational work is continuing on the development of smaller and less expensive equipment which could be used as a substitute for the equipment now specified in the tentative method of fire hazard classification of building materials E-84T.

A suitable definition of a noncombustible material has been under consideration for a long period without satisfactory results. Solution of this problem is now being sought on the basis that if a combustible material can be defined there will be no need for defining a noncombustible material. A cooperative effort by several laboratories is now under way to devise a test method which will serve this purpose.

E-6 Methods of Testing Building Constructions

COMMITTEE E-6 will cooperate with other interested ASTM Committees to arrive at a policy for establishing procedures for evaluating the fire resistance of materials and constructions so that fire tests can be carried out on a sound experimental basis and be made as economically as possible. The Tentative Methods of Testing Truss Assemblies (E 73 T) have been reviewed by the subcommittee and the changes proposed will be submitted to the membership of E-6 for action. A testing procedure for evaluating the strength and stiffness of floor and roof constructions for buildings is being developed and will, no doubt, be submitted for approval as a tentative during the coming year. The Tentative Methods of Conducting Strength Tests of Panels for Building Constructions (E 72 T) have been completely revised. Work is being continued to develop procedures for testing of joints in dwelling construction that will simulate actual service tests. In many instances wind damage to homes, garages, and barns could be largely prevented if proper attention would be paid to methods of fastening framing members together. Further attention will be given to methods of evaluating durability of constructions under simulated service tests and liaison will be maintained with other ASTM Committees in the preparation of procedures for evaluating the characteristics of insulation materials.

E-9 Fatigue

FATIGUE failures of tailshafts of ships and fatigue problems in aircraft design have increased the interest in the failure of large members. In an effort to develop fatigue data resulting from the use of large specimens, Committee E-9 has formed a Subcommittee on Large Machines and Test Correlation. The initial work of this new subcommittee will include the preparation of a summary of previous work on size effect, exploration of testing equipment now in custody of the Bureau of Ships, development of a test program, and plans for fund raising to carry out the test program.

The subject of nomenclature and symbols are under discussion between Committee E-9 and other committees having areas of common interest. Consideration is being given to a plan for providing a current fatigue literature reference service.

Joint Committee on Effect of Temperature on the Properties of Metals

ELSEWHERE in this BULLETIN reference is made to the extensive research work of this jointly sponsored ASTM-ASME committee. An intensive fund-raising program is under way to underwrite some of the major research work. While the chief concern of the committee is the development of information on the properties of metals, particularly at elevated temperatures but also including subatmospheric conditions, it has in its jurisdiction three standards covering short-time and long-time elevated temperature tests, E 21 and E 22, respectively, and recommended practice for rupture tension tests, E 85. Since other standard procedures are being considered in the working panels, and to coordinate this work the committee during the past year authorized a new "Panel on Test Methods" headed by J. J. Kanter, Crane Co. This group is being organized, with personnel being appointed by each of the other panels and additional members active in this work. The panel is reviewing the three standards noted above from the standpoint of current practice, and will report its findings to the Joint Committee.

Standard Paint Colors Chart

THE Canadian Government Specifications Board has issued recently a revised edition of its paint colors schedule.

The number of colors in this schedule have been kept to a minimum and yet the selection has been sufficiently broad to meet the most important requirements. The color chips in this chart are intended for direct visual color matching. The chromaticity coordinates and daylight luminous reflectance of all the color chips are expressed in terms of the system for colorimetry set up by the International Committee on Illumination and described in ASTM Method of Test for Spectral Characteristics and Color of Objects and Materials (D 307 – 44). These values are intended for reference purposes and as a means of detecting gradual changes in any of the color chips as a result of aging.

The color compilation can be procured through the Canadian Government Specifications Board, National Research Council, Ottawa, Canada, for $2 per copy.

Interested in Your School?

WOULD you be interested in underwriting one or more Student Membership Prize Awards to be established at your school? A number of ASTM members pay the cost ($2 annually) of Student Memberships which are awarded on recommendation of the faculties to worthy students at various schools. About 70 such awards have been set up at the following institutions:

University of California
University of Colorado
Iowa State College
Massachusetts Institute of Technology
Worcester Polytechnic Institute
Stevens Institute of Technology
Columbia University
Rensselaer Polytechnic Institute
Ohio Northern University
University of Toledo
University of Oklahoma
Oregon State College
University of Pennsylvania
University of Lausanne (Switzerland)
Karnataka Polytechnic (India)

If you are interested, a note to Headquarters will bring full information.

ASTM TECHNICAL COMMITTEE NOTES

Concerning Two Important Committees

AN EDITORIAL in the July 2, 1951, issue of the *American Paint Journal* comments on the activities of two ASTM committees, namely D-1 on Paint, Varnish, Lacquer, and Related Products, and Committee D-17 on Naval Stores.

The Editorial speaks for itself. Here it is:

Few of us realize the endless changes which constantly take place in our mode of life due to the introduction of new products and new materials for fabricating old ones, for the most part attributed to scientific research and testing methods which go on continually.

"Members of the paint, varnish, and lacquer industry are aware of the fact that many formulations and methods of testing become obsolete in a very short time because of the rapidity in the discovery of new materials.

"For over fifty years, the American Society for Testing Materials, as it is known throughout the world, has been concentrating its work in the fields of materials. The intensive activities have been channeled into two fields: (1) the standardization of specifications and methods of testing, and (2) research.

"Its purposes are achieved largely through the work of over 900 technical committees (each of which has from five to fifty standing subcommittees with personnel ranging in numbers from 25 to over 600) which are responsible for the development of over 1600 standard specifications and tests and for keeping them up to date.

"Research and standardization go hand in hand. Painstaking investigations and years of experience may be required before an adequate specification can be prepared, as agreement must be reached on the properties of materials and on methods of testing, as well as manufacturing details, methods of inspection, etc.

"While many in our industry are familiar with the work of the ASTM, there are also many who do not understand the functions of Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and Committee D-17 on Naval Stores, both active units of the Society, and the part these groups play in helping to keep the protective coatings industry among the top of all industries.

"Without the contributions made by these committees the already vast sums of money being spent for research and development by the paint industry, and others serving our industry, would have to be greatly increased.

"The members of these committees and subcommittees are conducting this work continually and without any monetary considerations, and it goes without saying that they deserve the highest praise and cooperation from all branches of our industry."

Research Work of Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals

Committee Issues Brochure in Financial Program

AN INTERESTING brochure covering some of the important accomplishments and projected new work of the Joint ASTM-ASME Committee on the Effect of Temperature on the Properties of Metals has been issued. The chief purpose is to provide the management of American industry and technical men with facts about the work of the Joint Committee in connection with the program to raise $85,000 so that important new research work can be advanced.

Prepared under the direction of the Finance Committee, headed by Norman L. Mochel, Westinghouse Electric Corp., with the close cooperation of Joint Committee Chairman Ernest L. Robinson, General Electric Co., the brochure gives a short historical statement and notes some of the accomplishments and publications of the committee. These have included standard methods, bibliographies, extensive symposia, engineering data and compilations, reports, and many sponsored papers.

The current activities covered by formal agreements include work on Graphitization, Effect of Manufacturing Variables on Creep Resistance, and High-Temperature Data Compilations.

The committee has numerous research projects which do not require any allocation of specific funds, the work being contributed by committee members and their companies, and handled in other ways. From these cooperative activities come many benefits, including important data on problems in this field. Some ten projects are included in this category as follows:

- Exploratory Investigation of High-Temperature Sheet Materials for Aircraft Applications.
- Compilation of Experience with Metals Above 1500 F.
- Behavior and Application of Metals at Low Temperatures.
- Relative Merits of 18 per cent Chromium, 8 per cent Nickel and Stabilized Grades of Austenitic Steels.
- Necessity for Preheating and Stress Relieving Ferritic Steels Welded with Austenitic Rods.
- Cracking at Welds of 12 per cent Chromium Liners in Pressure Vessels.
- Experience with Corrosion by Vanadium Compounds.
- Effect of Stress Concentration Factors on Rupture Life.
- Effect of Surrounding Atmosphere on Creep of Metals.
- Spread in High-Temperature Properties of Grade B Pipe to ASTM A 106, and in Plate to ASTM A 212.

New Research, Financial Program

There are some problems of urgent significance where professional personnel and facilities must be employed by the committee, and four such activities are either currently under way or ready to start:

- Statistical Evaluation of Creep-Rupture Properties of Certain Sheet Materials (Aviation Panel).
- Effect of Stress Concentration on Fatigue of Metals at Elevated Temperatures (Gas Turbine Panel).
- Collection, Compilation and Publication of High-Temperature Data (Data and Publications Panel).
- Elevated Temperature Properties of Cast Iron (Steam Power Panel, in Cooperation with ASTM Committee A-3 on Cast Iron).

The brochure discusses the financial problem as follows: The above four projects would require about $65,000. In addition several thousand dollars are needed immediately for the completion of work already under way, and in order to avoid another approach for funds in the near future, the committee has seen fit to ask for about $20,000 for future projects.

The committee has undertaken only four fund-raising campaigns (1927, 1930, 1936, and 1939) to which Industry and The Engineering Foundation subscribed a total of something over $60,000. With this modest sum, the com-

mittee has sponsored a large volume of research since 1927. At the same time, it has focused metallurgical attention on areas needing research, and catalyzed contributions-in-kind (donated services, materials, equipment, etc.) equivalent to many fold the actual cash valuation. At the present time, no unobligated balance remains from its last appeal initiated eleven years ago and from interim Foundation grants. Contributions for Joint Committee projects are deposited in a special custodian account administered for the two sponsor societies by ASME and are expended only on authority of the Joint Committee.

While the above paragraph outlines a tangible indication of the value of Joint Committee activities, by far the most important yardstick are the intangibles —fruitful ideas born of the hundreds of technical papers, symposia, and discussions sponsored by the committee over the years, which long since have lost their identification with this organization.

Letters are to go to leading organizations concerned with problems being studied by the Joint Committee, asking their cooperation in the financial program.

Wax Polish Committee Plans Research on Carnauba Wax

CARNAUBA wax has been known and used industrially for over fifty years. However, like many natural products, there is a considerable range in both physical and chemical properties among the various grades which are sold commercially. In an attempt to develop standard specifications, research projects have been under way in order to establish accurate test data. Committee D-21 on Wax Polishes and Related Materials, through its Subcommittee II on Raw Materials, is undertaking a cooperative research project for detecting wax additives. A sample of carnauba wax to which paraffin has been added is being sent to those members of the subcommittee who have signified a desire to participate. The test procedure to be used will follow that which is outlined in an article entitled "Detecting Wax Additives," by Marsel, Treacy, and Godino, which was published in the July, 1951, issue of *Soap*. The chairman of the subcommittee, Melvin Fuld of Fuld Brothers, Inc., Baltimore, Md., has indicated that anyone desiring to cooperate with the subcommittee in this cooperative work would be welcome. In addition, test data will be collected on the separation of wax constituents into general chemical groups by displacement chromatography as outlined in an article by Broadhead, Gericke and Wilder, "Simple Methods for Separating Wax Constituents into General Chemical Groups by Displacement Chromatography."

A second research project which is being inaugurated will involve round-robin testing of samples of carnauba wax No. 3 for determination of dirt and water. This will include the use of the ASTM Method of Test for Water in Petroleum Products (D 95) and for Water and Sediment by Means of Centrifuge (D 96 T). All information on these two projects will be collected by Chairman Fuld and then sent to Dr. Walton at the National Bureau of Standards for further analysis, tabulation, and study.

Symposium on Testing Metal Powders and Metal Powder Products Being Organized

COMMITTEE B-9 on Metal Powders and Metal Powder Products plans to arrange for a symposium on methods of testing for metal powders and metal powder products during the next ASTM Spring Committee Week to be held in Cleveland in March, 1952. While many symposia have been held on the scientific and technical aspects of powder metallurgy this is believed to be the first symposium specifically concerned with methods of testing.

Powder metallurgy as a production method has made rapid progress during the past few years. New and improved methods for testing powders and fabricated parts are constantly being evolved. The proposed symposium should serve as a medium of providing information for all who are interested in this field. Papers concerned with any phase of the testing of metal powders or of parts fabricated from powders are invited. It is suggested that anybody interested in contributing such a paper contact F. V. Lenel, Secretary of Committee B-9, Rensselaer Polytechnic Institute, Troy, N. Y.

Aluminum Die Castings—the Effect of Process Variables on Their Properties

A REPORT of the work of Subcommittee IX on Die-Casting Processes of ASTM Committee B-6 on Die-Cast Metals and Alloys was included as an appendix to the 1951 B-6 Report in the form of a paper by W. Babington and D. H. Kleppinger.

The first work undertaken by this subcommittee was the design of a test casting die intended to serve as a tool for later studies of the process variables. The test program consisted of producing castings using a pressure range of 500 to 100,000 psi employing gate thicknesses of 0.030 and 0.090 in. Every effort was made to hold those casting conditions not under investigation as constant as possible and to measure the variables being studied, such as measurement of temperature, metal pressure, and plunger speed, with the highest degree of accuracy compatible with efficient operation of the die-casting unit.

The 24 figures in the report include photographs of die castings produced under various conditions as well as numerous graphs which present a comparison of the mechanical test values, quality indices, and radiographic soundness ratings with various conditions of gating, venting plunger speed, and metal pressure.

Based upon the results obtained from this study, and subject to the limitations of the conditions covered, the following conclusions are drawn:

1. Satisfactory instrumentation has been developed for the measurement of die-casting process variables and includes:
   (*a*) Metal-pressure-measuring system employing SR-4 strain gages on direct-reading electronic recorders.
   (*b*) Die-face temperature measurement by means of the Leeds & Northrup Rayotube and Speedomax Recorder.
   (*c*) Plunger-speed measurement, employing both a Leeds & Northrup recording unit and a Western Electric Co. drum-type recorder.
2. This instrumentation is eminently practical and can be used to control the die-casting process.
3. The results show that the test die produced castings having the highest quality under the following conditions:
   (*a*) Measured metal pressure—20,000 psi,

(*b*) Thin gate (approximately 0.030 in.),
(*c*) High-plunger speed (approximately 375 ft per min), and
(*d*) Adequate die venting.

Some deterioration in quality occurs at extremely high pressures. A minimum measured pressure of approximately 5000 psi is required to produce castings considered "commercially acceptable."

4. Castings made with a 0.030-in. gate had consistently higher quality indices and mechanical properties, under comparable casting conditions, than those made with a 0.090-in. gate. Comparison has only been made between extremely thin and thick gates. On this basis, the superiority of the 0.030-in. gate over the 0.090-in. gate has been frequently indicated. But since no other gate size was studied, it should not be construed from those data that 0.030 in. is the optimum gate thickness.

5. The soundness and strength of castings made with a high plunger speed are superior under comparable conditions of pressure and venting to that of castings made with a slow plunger.

6. The thickness of die gate appears to be a factor in the relationship between calculated pressure and measured metal pressure.

7. A relationship is established between radiographic soundness and tensile strength by which maximum tensile strength may be predicted from soundness ratings.

8. Further work along the lines of this investigation should include:
(*a*) Refinement of the test casting die to improve gating and venting.
(*b*) Measurement of metal pressure at points within the actual die cavity.

Emergency Alternate Provisions Issued Affecting Steel Tubes and Pipe, Rubber and Friction Tape

In line with the new procedures for establishing Emergency Alternate Provisions approved by the Board of Directors May 8, a number of Emergency Alternates have been issued on the recommendations of several of the technical committees. These provisions appear below. They are also being printed in the form of "pink" slips and a copy of each Emergency Alternate can be procured by members on request.

Editor's Note.—Reference has been made to some of these Emergency Alternate Provisions in a news article appearing in the July issue, also see p. 5 this September issue.

EA–A 199, EA–A 200, EA–A 249

Issued June 10, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in the following specifications and affect only the requirements referred to:

Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199 – 51 T).
Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200 – 15 T).
Welded Alloy Steel Boiler and Superheater Tubes (A 249 – 47).

Section 5.—In Paragraph (*a*) revise the third sentence to read as follows by the addition of the italicized words:

"The chemical composition thus determined shall conform to the requirements prescribed in Table I, *except the maximum requirement for phosphorus content on check analysis for all grades shall be 0.045 per cent.*"

Revise Paragraph (*b*) to read as follows by the addition of the italicized words:

(*b*) If the analysis of one tube does not conform to the requirements specified, an analysis of two additional tubes from the same lot shall be made, each of which shall conform to the requirements prescribed in Table I, *except the maximum requirements for phosphorus content on check analysis for all grades shall be 0.045 per cent.*

Table I.—For all grades change the present requirement for maximum phosphorus content on check analysis to read "0.045" per cent.

EA–A 268, EA–A 269, EA–A 270, EA–A 271

Issued June 10, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in the following specifications and affect only the requirements referred to:

Seamless and Welded Ferritic Stainless Steel Tubing for General Service (A 268 – 47).
Seamless and Welded Austenitic Stainless Steel Tubing for General Service (A 269 – 47).
Seamless and Welded Austenitic Stainless Steel Sanitary Tubing (A 270 – 47).
Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service (A 271 – 47).

Section 4 (*a*).—Revise to read as follows by the addition of the italicized words:

4. (*a*) The steel shall conform to the requirements as to chemical composition prescribed in Table I, *except that the maximum requirement for phosphorus content of all grades shall be 0.040 per cent on ladle analysis and 0.045 per cent on check analysis.*

Section 5.—In Paragraph (*a*) revise the third sentence to read as follows by the additions of the italicized words: "The chemical composition thus determined shall conform to the requirements prescribed in Table I, *except that the maximum requirement for phosphorus content of all grades on check analysis shall be 0.045 per cent.*"

Revise Paragraph (*b*) to read as follows by the addition of the italicized words:

(*b*) If the analysis made in accordance with Paragraph (*a*) does not conform to the requirements prescribed in Table I *with the exception that the maximum requirement for phosphorus content on check analysis for all grades shall be 0.045 per cent,* an analysis of each billet or tube from the same heat may be made, and all billets or tubes thus conforming to the requirements shall be accepted so far as chemical composition is concerned.

Table I.—For all grades change the present requirement for maximum phosphorus content of "0.030" to read "0.040" per cent on ladle analysis and "0.045" per cent on check analysis.

EA–A 213

Issued June 10, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in ASTM Tentative Specifications for Seamless Alloy Steel Boiler and Superheater Tubes (A 213 – 51 T) and affect only the requirements referred to:

Section 5.—In Paragraph (*a*) revise the third sentence to read as follows by the addition of the italicized words:

"The chemical composition thus determined shall conform to the requirements prescribed in Tables I and II, *except maximum requirement for phosphorus content on check analysis for all grades shall be 0.045 per cent.*"

Revise Paragraph (*b*) to read as follows by the addition of the italicized words:

(*b*) If the analysis of one of these test specimens does not conform to the requirements prescribed in Tables I and II *with the exception that the maximum requirement for phosphorus content on check analysis for all grades shall be 0.045 per cent,* an analysis of each billet or tube from the same heat may be made, and all billets and tubes thus conforming to the requirements shall be accepted.

Tables I and II.—For all grades change the present requirement for maximum phosphorus content on check analysis to read "0.045" per cent.

EA–A 312

Issued June 10, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in ASTM Tentative Specifications for Seamless and Welded Austenitic Stainless Steel Pipe (A 312 – 51 T) and affect only the requirements referred to:

Section 6.—Revise to read as follows by the addition of the italicized words:

6. Each alloy shall conform to the requirements as to chemical composition prescribed in Table I, *except that*

the maximum requirement for phosphorus content of all grades shall be 0.040 per cent on ladle analysis and 0.045 per cent on check analysis, or to other chemical composition requirements as specified in the order.

Table I.—For all grades change the present requirement for maximum phosphorus content of "0.030" to read "0.040" per cent on ladle analysis and "0.045" per cent on check analysis.

EA-D 69

Issued May 26, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in ASTM Tentative Specifications for Friction Tape for General Use for Electrical Purposes (D 69 – 48 T) and affect only the requirements referred to:

Section 8.—Change the requirements for the number of pinholes in a specimen of three consecutive yards of tape to read as follows:

Tape Width, in.	Number of Pinholes, max
¾	12
1	16
1¾	24
2	32

Section 20.—Omit Paragraph (*b*) of this section which describes the oven test for adhesion.

EA-D 119

Issued May 26, 1951

The following Emergency Alternate Provisions, when specified, may be used as an alternate in ASTM Tentative Specifications for Rubber Insulating Tape (D 119 – 48 T) and affect only the requirements referred to:

Section 2.—Change the first sentence from its present form to read as follows by the addition of the italicized words and the omission of those in brackets:

2. The tape shall consist of an unvulcanized or partially vulcanized [natural] rubber insulating compound. *The compound* [which] shall contain not more than 0.5 per cent of free sulfur by weight of the original compound when tested in accordance with the procedure described in Section 21.

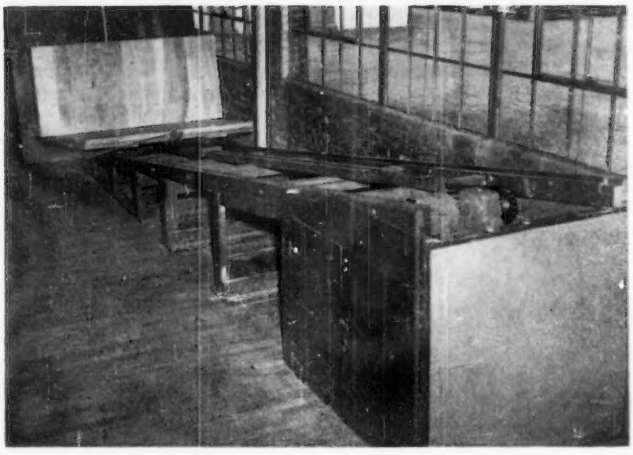
Section 4.—In Paragraph (*a*) change the requirement for tensile strength from "250 psi" to "200 psi."

In Paragraph (*b*) change the requirement for elongation of a 2-in. gage length from "300 per cent" to "250 per cent."

Section 5.—Change the requirement for dielectric strength from "350 v" to "275 v" per mil of thickness.

H. S. Vassar Dies

Word is just received of the death of Hervey S. Vassar, Past-President and Honorary Member. The October Bulletin will carry a further article.



New Incline Impact Testing Device Containers as wide as 76 in. can be released from as far as 13 ft. from the steel and oak bumper.

New Conbur Testing Machine Completed:

A new Incline Impact (Conbur) Testing device has just been completed at Package Research Laboratory, Rockaway, N. J. This new apparatus replaces one used in testing a great variety of packaged articles for the past 14 yr. The original apparatus was one of the first ever used.

This new testing device accommodates loads up to 1000 lb and packages 78-in. high or 76-in. wide. The "bumper" is constructed of steel channels, oak boards, and a steel face plate. The dolly, 60 by 72 in., is faced with maple boards and is mounted on 6 roller bearing wheels which run on two steel tracks spaced approximately 33 in. apart. Although it is possible to release the dolly from as far as 13 ft from the bumper, a fifth zone shock is obtained from a run of only 28 in.

One of the advantages of this new testing device is that it is now a one-man operation. The dolly is provided with a latch to engage one of the many lugs on a central chain. When not engaged, the latch is held clear of the chain by a spring. The operator starts the chain at the beginning of a test and does not stop it until the test is completed. A release is positioned in the middle of the track to automatically disengage the latch when the dolly has reached a predetermined position.

The Incline Impact Tester is used in the National Safe Transit Committee and is described in the ASTM Standard D 880, and the Technical Association of the Pulp and Paper Industry, Method T 801sm.

Handbook on Bituminous Construction

THE 1951 edition of the Bituminous Construction Handbook, published by Barber-Greene Co., contains a wealth of engineering data and information on accepted practices in bituminous construction. The expansion of this handbook from its original coverage of data pertaining to the erection and operation of Barber-Greene Bituminous Plants and Finishers to its present form has been considerable. Chapters are now included on the various types and classifications of bituminous road surfaces, bases, sub-bases, and drainage. Other related subjects, such as central plant material flow and control, drying and dust collection, the principles of operation and use of materials in tamping and leveling road surfaces, and requirements for boilers, tanks, and pipe, are covered in the handbook. An interesting feature is the abundance of simple diagrams and figures, as well as photographs, which illustrate the technical discussion. A section on engineering data contains a very comprehensive coverage of tables useful to the highway engineer.

Copies of this handbook are available from Barber-Green Co., Aurora, Ill., at a cost of $2.

—About Books—

Excerpted from "Intellectual Thoroughfares" by Douglas M. Black, President, Doubleday & Company—Saturday Review of Literature, July 7, 1951.

The theme of the Association's (American Library Association) celebrations during its anniversary year is "The Heritage of the United States in Times of Crisis." Many thoughts come to mind when we attempt to define the American heritage. But in essence they all boil down to one word: freedom. And freedom of expression is found more substantially in books than in any other medium of communication. Unencumbered by advertising and uninfluenced by advertisers, published privately and independently by relatively small firms usually managed by their owners, books are the freest of all the media of communication. It is safe to say that any man with a serious message to communicate and the ability to express it in understandable language can find a publisher for his book.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

The following ASTM members are among eight American and Canadian textile experts recently elected to Fellowship and Associateship by the International Textile Institute, Manchester, England: **George S. Buck, Jr.,** Technical Director, National Cotton Council of America, and founder of the Cotton Research Clinic, who has published several papers on cotton subjects and lectured extensively; **Richard Shoemaker Cox,** Dean of the Philadelphia Textile Institute where for 51 years he has taught and supervised technological courses; **Herbert Frederick Schiefer,** Physicist, Textiles Section, National Bureau of Standards, Washington, D. C., who has worked on the development of new instruments and methods for measurement of textile properties and made noteworthy contributions to the fundamental knowledge of textile fibers and yards; and **Walter M. Scott,** Assistant Chief, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, who has published some seventy treatises, and has taken out patents connected with problems of dyeing and chemistry of textile fibers.

Kenneth A. Arnold has been put in charge of the newly consolidated Research and Development Dept. of St. Regis Paper Co., Deferiet, N. Y. He has been Research Director of the Multiwall Bag Division.

C. K. Banks has been appointed to the office of Vice-President in Charge of Research of the Metal & Thermit Corp., New York City. Dr. Banks has been the company's Director of Research since 1949.

R. B. Caples, Manager, Great Falls Reduction Dept., Anaconda Copper Mining Co., Great Falls, Mont., was elected President of the American Zinc Institute at its thirty-third annual meeting in May. **G. Howard LeFevre,** Manager of Metal Sales, U. S. Smelting, Refining & Mining Co., New York City, was one of three newly elected Vice-Presidents. **Ernest V. Gent** continues as Executive Vice-President and Secretary of the Institute.

Shreve Clark, for many years Engineer of Tests, Virginia Dept. of Highways, Richmond, retired on June 30. Mr. Clark had represented the Virginia Highways Department's membership in the Society since 1920, and through the years had been active in various technical groups including Committees C-9 on Concrete and Concrete Aggregates, D-4 on Road and Paving Materials, and D-18 on Soils for Engineering Purposes. He is a Past-Chairman of D-4, and his contributions to ASTM work in this field were recognized by this group earlier this year when he was elevated to honorary membership.

Milford H. Corbin, President, Standard Varnish Works, Staten Island, N. Y., was elected President of the New York Paint, Varnish and Lacquer Assn. at its annual meeting in May.

Humphrey Dell, of the Glidden Co., was elected President of the Cleveland Paint and Varnish Production Club; and **Robert Hall,** Technical Director, Paint Dept., United Co-Operatives, Inc., was elected Secretary at the May meeting of this group.

Harry W. Dippel, former Vice-President of Stillwell & Gladding, Inc., New York City, has succeeded Ralph W. Bailey as President of his company. Associated with the firm for over thirty years, he will continue also as Laboratory Director.

W. P. Dobson, Director of Research, Hydro-Electric Power Commission of Ontario, Toronto, was awarded the honorary degree of doctor of science by Queen's University. Affiliated for many years with ASTM as representative of the sustaining membership of the Commission, Mr. Dobson has been very active also as Chairman of the Approvals Council of the Canadian Standards Association, as noted in the "Personals" column of the May, 1951, issue of this BULLETIN.

Thomas E. Eagan has been promoted to the position of Research Metallurgist for Cooper-Bessemer Corp., Mt. Vernon, Ohio.

O. W. Ellis, Director, Department of Engineering and Metallurgy, Ontario Research Foundation, Toronto, has been awarded the Leonard Medal of the Engineering Institute and the Canadian Institute of Mining and Metallurgy. The paper meriting the award entitled "A Study of Some Alloys of Titanium in the Manufacture of Which Commercial Titanium Hydride Was Used," was written by Dr. Ellis in collaboration with H. V. Kinsey, Mines Branch, Ottawa; and W. E. Kuhn, National Lead Co., Niagara Falls, N. Y.; and was published in the February, 1950 issue of the CIMM "Bulletin." Affiliated with ASTM for many years, Dr. Ellis has been active in a number of the technical groups, as well as in the Western New York-Ontario District Council, where he served successively for two-year periods as Vice-Chairman and Chairman.

Samuel A. Gordon, formerly Assistant Chief of Structures, Piasecki Helicopter Corp., Morton, Pa., is now Technical Consultant, Battelle Memorial Institute, Columbus, Ohio.

Charles A. Hemenway has accepted a position as Chief Inspector, Sibley Machine & Foundry Co., South Bend, Ind.

J. W. Hepplewhite, who recently completed his term as President of The American Ceramic Society, is now on the staff of Ferro Enamel Corp., Cleveland. He was formerly employed by the Edwin M. Knowles China Co., Newell, W. Va.

M. E. Holmberg has opened his own offices as Metallurgical Consultant in Houston, Tex. He had been affiliated previously with Phillips Petroleum Co., Bartlesville, Okla., as Manager, Test Div.

Arthur V. Hughes, formerly on the staff at Battelle Memorial Institute, Columbus, Ohio, as Research Engineer, is now Director of Engineering, Kuhlman Electric Co., Bay City, Mich.

Robert W. Hunt Co., Engineers, Chicago, Ill., announce that L. F. Bross has been advanced to Manager of their Rail & Track Fastenings Dept. A. A. Bareuther, whom Mr. Bross succeeds, is on leave of absence due to his health.

Gus Kaufman has been named Assistant Manager, Technical and Research Div., The Texas Co., New York City, headed by **Wayne E. Kuhn.** A lubrication specialist, Dr. Kaufman spent ten years in charge of grease research at the firm's Beacon laboratories prior to becoming Staff Technologist and Assistant to the Manager, Technical and Research Div., which position he has held until his recent promotion.

Georgé V. Luerssen, Chief Metallurgist, was appointed Vice-President in Charge of Metallurgy by Carpenter Steel Co., Reading, Pa., succeeding B. H. DeLong who retired after 41 years service. **Carl B. Post** has been promoted to Chief Metallurgist.

Vincent Lysaght has been appointed Sales Manager of the Helicoid Gage Div., American Chain & Cable Co., New York City. Mr. Lysaght has directed the sales of the Campbell Machine Division and Wilson Mechanical Instrument Div.(Rockwell Hardness Testers) in the past, and will continue as Sales Manager of the Wilson and Campbell Divisions. Affiliated with ASTM for many years, Mr. Lysaght has rendered service on numerous technical committees.

D. H. Marlin has been named Assistant to the Manager of the Engineering Development Dept., Dravo Corporation's Engineering Works Div., Pittsburgh, Pa. Mr. Marlin joined Dravo in 1941 as a metallurgical engineer, specializing in welding practices.

J. L. McCloud, Manager of Manufacturing Research, Ford Motor Co., Dearborn, Mich., has been elected President of The Engineering Society of Detroit. Widely known throughout chemical and engineering circles, Mr. McCloud is a Past-Director of ASTM and Past-Chairman of the Detroit District Council.

Don M. McCutcheon has been named Manager of the Physics Dept., Scientific Laboratory, Ford Motor Co.

Carl A. Menzel, Manager, Housing and

Cement Products Bureau, Portland Cement Assn., Chicago, Ill., was awarded the 1951 Award of the Concrete Reinforcing Steel Institute in recognition of his research and development work on the A 305 (ASTM) reinforcing bar. Since 1918 Mr. Menzel has been engaged almost continuously in research, testing, and development work on building materials and construction. He was recipient in 1932 of the ASTM Dudley Medal for his investigation of the fire resistance and stability of concrete masonry walls; and in 1948 the American Concrete Institute awarded him the Wason Medal for his paper on "Apparatus and Methods for the Determination of the Air Content of Fresh Concrete."

J. J. Mikita recently returned to the Du Pont Petroleum Laboratory as Director, which post he previously had occupied from 1946 to 1949. Since then he had served as Assistant Technical Manager at the Wilmington Office. His return to the laboratory was prompted by the expanding activity of petroleum chemicals research being carried on at the new quarters.

Howard G. Minckler, formerly associated with the Alaska Road Commission as Highway Engineer, is now Asphalt Inspector, J. E. Greiner Co., Baltimore, Md.

Glenn Murphy, Professor of Theoretical and Applied Mechanics and Senior Engineer for the Iowa State College Institute for Atomic Research, was the sixth recipient of the George Westinghouse Award of the American Society for Engineering Education. A master craftsman of the teaching art, Dr. Murphy received this honor in recognition of his contributions to the improvement of teaching methods for engineering students.

J. J. O'Neill heads the recently established special Paint Development Laboratory within the Chemical Div. of The Goodyear Tire & Rubber Co., Akron, Ohio.

Carl R. Reid, formerly Assistant Materials Engineer, Pennsylvania Turnpike Commission, New Kensington, Pa., is now associated with Quinton Engineers, Ltd., Los Angeles, Calif.

Charles H. Samson, Jr., has accepted a position as Structures Engineer, Consolidated Vultee Aircraft Corp., Fort Worth, Tex. He was previously on the teaching staff at the University of Missouri.

David C. Scott, Jr., is now President and Sales Manager, Scott Testers, Inc., Providence, R. I., succeeding his father who died in May. (See "Instrument Company notes.")

Charles E. Schaffner, until recently Assistant Professor, Department of Civil Engineering, Polytechnic Institute of Brooklyn, has been appointed Director of the Evening Div. of the Institute, one of the largest evening sessions in the country devoted solely to the engineering curriculum. A well-known consultant on materials testing and stress analysis, Prof. Schaffner is the fourth director of the Polytechnic Evening Session since the post was created in 1910, the session itself having been organized in 1904.

Harry A. Schwartz, Manager of Research, National Malleable and Steel Castings Co., Cleveland, Ohio, was awarded the 1951 McCrea Medal of the Malleable Founders' Society, in recognition of outstanding service to the malleable castings industry. Named in honor of a former President of Mr. Schwartz's company, the medal is awarded annually to individuals selected by a committee of leading authorities. Active in ASTM for many years, Mr. Schwartz serves on numerous technical committees including A-7 on Malleable-Iron Castings, of which he was Secretary from 1936 to 1947. He was the first Chairman of the ASTM Cleveland District, serving for seven years, and has given outstanding service in other ASTM work. He has received many honors for his accomplishments in engineering and metallurgy.

Edwin K. Smith, formerly Consulting Metallurgist, is now Ordnance Engineer with the Ordnance Corps, U. S. Department of the Army, Los Angeles, Calif.

R. W. Steigerwalt has been appointed Metallurgical Adviser, Railroad Materials and Commercial Forgings, United States Steel Co., Pittsburgh, Pa. Well known for his work in connection with railroad materials and forgings, Mr. Steigerwalt has served for many years as a member of ASTM Committee A-1 on Steel, its advisory group and a number of its subcommittees; and is presently a member of the Pittsburgh District Council.

Arthur A. Wells, Vice-President and General Supt., Homer Laughlin China Co., Newell, W. Va., was elected a Vice-President of the American Ceramic Society at its recent annual meeting.

NEW MEMBERS . . .

The following 80 members were elected from June 21, 1951, to August 13, 1951, making the total membership 6994 . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first, then individuals

Chicago District

DETRICK, M. H., Co., H. A. Rowley, Service Engineer, 111 Washington Blvd., Chicago 2, Ill.

MINNESOTA LINSEED OIL CO., G. N. Walker, Superintendent of Plants, 25 Forty-fourth Ave., N. E., Minneapolis 21, Minn.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS, W. F. Leonard, Secretary and Assistant Treasurer, 343 S. Dearborn St., Chicago 4, Ill.

BETTER, BERNARD, Director of Research, Scully-Jones and Co., 1901 S. Rockwell, Chicago 8, Ill.

CHICAGO, CITY OF, DEPARTMENT OF PURCHASES, CONTRACTS, AND SUPPLIES, TESTING AND INSPECTION DIV., ASPHALT LAB., James L. Faulkner, Engineering Chemist, 1533 S. Ashland Ave., Chicago 8, Ill.

MORTIMER, KENNETH, Assistant Professor, Valparaiso University, Valparaiso, Ind.

ROGERS, MARVIN C., Research Director, R. R. Donnelley and Sons Co., 350 E. Twenty-second St., Chicago 16, Ill. For mail: 2043 Cummings Lane, Flossmoor, Ill.

Cleveland District

OPERATIVE PLASTERERS' AND CEMENT MASONS' INTERNATIONAL ASSN., James M. Myles, Vice-President, 200 Fidelity Bldg., Cleveland 20, Ohio.

PHILLIPS, J. H., Chief Chemist, The Babcock & Wilcox Co., Box 835, Alliance, Ohio.

SMITH, ARTHUR L., Manager, Research and Development, Continental Can Co., Inc., Plastics Div., Cambridge, Ohio.

Detroit District

DUDZINSKI, JOSEPH J., Materials Engineer, Ordnance Tank Automotive Center, Centerline, Mich. For mail: 6005 Cadieux Rd., Detroit 24, Mich.

PULK, RAYMOND A., Chief, Materials Lab., Detroit Arsenal, Centerline, Mich. For mail: 18701 Mansfield, Detroit 35, Mich.

SMITH, FREDERICK W., Supervisor, Chemical Engineering Research, Wyandotte Chemicals Corp., 1609 Biddle Ave., Wyandotte, Mich.

TEAGUE, D. M., Assistant Head of Chemical Research, Chrysler Corp., Central Engineering, Box 1919, Detroit 31, Mich.

WILSON, GROVER C., Research Supervisor, Ethyl Corp., 1600 W. Eight-Mile Rd., Detroit 20, Mich.

New England District

CROCKER, BURBANK PAPERS, INC., J. L. McClellan, Sr., Technical Director, 545 Westminster St., Fitchburg, Mass.

STANLEY HOME PRODUCTS, INC., D. J. Templeton, Director, Laboratory and Production, Easthampton, Mass.

COOPER, LESTER S., Chemist, Hartford Rd., Columbia, Conn.

MINER, A. E., Engineering Laboratory Manager, General Electric Co., Telechron Dept., Homer Ave., Ashland, Mass.

RICHARDS, RAYMOND R., General Manager, Koehler Manufacturing Co., Marlboro, Mass.

WARNER, A. KENNETH, 16 Lyndon Rd., Melrose 76, Mass.

New York District

MYCALEX CORP. OF AMERICA, A. J. Monack, Manager, Technical Service Dept., 60 Clifton Blvd., Clifton, N. J.

BURNS, ROBERT, Production Manager, Fabric Finishing, Celanese Corp. of America, 180 Madison Ave., New York 16, N. Y.

COHN, EUGENE, Vice-President, Secon Metals Corp., 228 E. Forty-fifth St., New York 17, N. Y.

DELGASS, EUGENE B., Chemical Engineer, Socony-Vacuum Oil Co., Inc., Technical Service Dept., 412 Greenpoint Ave., Brooklyn 22, N. Y. For mail: 88 Poplar St., Garden City, N. Y.

DETWILER, KARL E., Chief, Production Engineering Section, Karlsfeld Ordnance Depot, APO 407, c/o Postmaster, New York, N. Y. [J]*

FISCHER, DAVID PAUL, Vice-President, H., and D. Fischer Industries Corp., 92 E. Jericho Turnpike, Mineola, N. Y. [J]

GRIFFITH, JOHN M., Engineer of Research, The Asphalt Inst., 801 Second Ave., New York 17, N. Y.

KUHN, R. EDWARD, Assistant Engineer, Howard, Needles, Tammen & Bergendoff, 55 Liberty St., New York 5, N. Y.

MCCLINTOCK, JOHN H., Manager, Oil Loss Prevention Div., Esso Standard Oil Co., 15 W. Fifty-first St., New York 19, N. Y.

NATIONAL BOARD OF FIRE UNDERWRITERS,

Everett W. Fowler, Assistant Chief Engineer, 85 John St., New York 7, N. Y.
TUTHILL, MARSHALL W., President, Tuthill and Co., Inc., 60 Wall St., New York 5, N. Y.

Northern California District

COAST MANUFACTURING AND SUPPLY CO., Robert J. Irvine, Manager, Quality Control, Box 71, Livermore, Calif.
ESTCOURT, V. F., General Superintendent of Steam Generation, Pacific Gas and Electric Co., 245 Market St., San Francisco 6, Calif.

Ohio Valley District

FULLER, R. GLEN, Research Engineer, Battelle Memorial Inst., Columbus 1, Ohio. For mail: 2244 S. Halifax Ave., R.F.D. 2, Daytona Beach, Fla.
HORNE, EDWARD L., Materials Engineer, Wright-Patterson Air Force Base, Dayton, Ohio. For mail: 605 Randolph St., Dayton 8, Ohio.
JORDAN, JOHN F., Chief Engineer, The Baldwin Co., 1801 Gilbert Ave., Cincinnati 2, Ohio.
KAHLES, JOHN F., Partner, Metcut Research Associates, 6305 Warrick St., Cincinnati 27, Ohio.

Philadelphia District

KULJIAN CORP., THE, Frank R. Simpson, Director of Research, 1200 N. Broad St., Philadelphia 21, Pa.
NORTH EAST INDUSTRIES, INC., George Krauss, Plant Manager, 4041 Ridge Ave., Philadelphia 29, Pa.
PHOENIX MANUFACTURING CO., Thomas W. Howlett, Sr., General Manager, Front and Chapel Sts., Catasauqua, Pa.
SMITH, KLINE & FRENCH LABORATORIES, Paul A. Geary, Chief Inspector, 1530 Spring Garden St., Philadelphia 1, Pa.
FINCH, DONALD I., Chief, Metallurgical Div., Research Dept., Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.
JOHNSTON, MARY A., Technical Librarian, Lukens Steel Co., Technical Library, Coatesville, Pa.
MARTIN, A. HAROLD, Research Engineer, Scott Paper Co., Chester, Pa.

Pittsburgh District

HOPPEL, G. C., JR., Associate, Puderbaugh & Hoppel, 207 James Ave., Patton, Pa.
KIMMEL, RALPH P., Metallurgist, United States Steel Co., Johnstown Works, 545 Central Ave., Johnstown, Pa.
QUENEAU, BERNARD R., Chief Metallurgist, United States Steel Co., Duquesne, Pa.
ROBINSON, JAMES C., Assistant to Manager, Materials Dept., Robert W. Hunt Co., Engineers, 923 Penn Ave., Pittsburgh 22, Pa.

St. Louis District

DIXON MANUFACTURING CO., INC., E. Oran Talbot, Jr., Laboratory Supervisor, Coffeyville, Kans.
HAHN, ROBERT L., Chief Structural Engineer, Jones-Hettelsater Construction Co., 1911 Baltimore, Kansas City 8, Mo.
KIBURZ, FRED H., Highway Engineer, County of St. Louis, Mo., Highway Engineer's Office, Court House, Clayton 5, Mo.

Southern California District

HOWE, JOHN B., Associate; and Field Engineer, Maurseth & Howe, 8953 S. Western Ave., Los Angeles 47, Calif.
KUSCHE, R. O., President, Quinton Engineers, Ltd., 816 S. Figueroa St., Los Angeles 17, Calif.
ROMIG, HARRY G., Staff Engineer, Quality Control, Industrial Engineering, American Society for Quality, 22 E. Fortieth St., New York 16, N. Y. For mail: c/o Hughes Aircraft Co., Florence Ave. at Teale St., Culver City, Calif.

Washington (D. C.) District

OLIN INDUSTRIES, INC., Milton O. Schur, Director of Research and Development, Ecusta Paper Corp., Pisgah Forest, N. C
GOULD J. THOMAS, Materials Engineer, Material Sales Co., P.O. Drawer 1040, Salisbury, N. C.
NATIONAL PRODUCTION AUTHORITY, DEPARTMENT OF COMMERCE, FACILITIES AND CONSTRUCTION BUREAU, Washington 25, D. C.

Western New York-Ontario District

CANADIAN HANSON & VAN WINKLE CO., LTD., Douglas H. Hanna, Chief Chemist, Corner Silver and Morrow Aves., Toronto, Ont., Canada.
NATIONAL METALCLAD DOOR ASSN., INC., Malcolm E. Fischer, Executive Secretary, 266 Bryant St., Buffalo 22, N. Y.
FROST, RICHARD H., Assistant Chief Engineer, Stanley Aviation Corp., Buffalo Municipal Airport, Buffalo 25, N. Y.
HODGSON, GEORGE F., Metallurgist, Doehler-Jarvis Corp., Batavia, N. Y. For mail: 24 Lewis Ave., Batavia, N. Y.
HOUGH, B. K., 237 Renwick Dr., Ithaca, N. Y.

U. S. and Possessions

CARBIDE AND CARBON CHEMICALS CO., PLANT K-25, CENTRAL LIBRARY, Evelyn Levine, Librarian, Box P, Oak Ridge, Tenn.
SOUTHERN INSPECTION SERVICE, Philip D. Barnard, General Manager, Box 8633, Houston 9, Tex.
BISHOP, CHARLES K., Resident Manager, Washougal Woolen Mills, Washougal, Wash. For mail: 800 Washington St., Washougal, Wash.
CAPLAN, S. D., Manager, Engineering Services, 601 Continental Bank Bldg., Salt Lake City, Utah.
FORD, HUGH P., Manager, Eugene Concrete Pipe and Products Co., Box 947, Eugene, Ore.
PANAMA CANAL, THE, MUNICIPAL DIVISION, Frank H. Lerchen, Municipal Engineer, Box Q, Balboa Heights, Canal Zone.
SULLIVAN, MICHAEL J., Chemist, Arizona Fertilizers, Inc., Box 2828, Phoenix, Ariz. For mail: 3802 N. Fourteenth Pl., Phoenix, Ariz.

Other than U. S. Possessions

FUNDICIONES DE HIERRO Y ACERO, S. A., Juan Latapi, Plant Engineer, Prol. Calle Diez Num. 145, San Pedro de los Pinos, Mexico 18, D. F., Mexico.
HOGANAS-BILLESHOLMS AKTIEBOLAG, E. Bengtsson, Chief Engineer, Hoganas, Sweden.
ALTINYILDIZ, MESIH, Chemical Engineer, State Shipping Lines Ad., Galata, Istanbul, Turkey. For mail: Huseyinagacami S. No. 5, Carsikapi, Istanbul, Turkey.
DANEL, PIERRE, Director of Hydraulic Laboratory, Neyrpic-Grenoble, Box 52, Grenoble, France.
DICKENS, H. A., Manager, Nilcrom Porcelains (Aust.) Pty., Ltd., 221 Separation St., Northcote N. 16, Victoria, Australia.
JAPAN SYNTHETIC TEXTILE INSPECTION INST., Kyuichi Ohata, President, No. 5 3-chome, Gofukubashi, Chuo-ku, Tokyo, Japan.
MUNOZ, MANUEL DE LA CRUZ, Professor of Strength of Materials, Universidad de Oriente, Ave. de Cuabitas, Santiago de Cuba. For mail: Corona 507 (altos), Santiago de Cuba, Oriente, Cuba.
OGMEN, TURGUT, Chemical Engineer, M.T.A. Refinery, Batman-Diyarbakir, Turkey. For mail: Bagdat cad., 253/1, Kiziltoprak, Istanbul, Turkey. [J]
REITSEMA, R., Director, Metals Research Inst., T. N. O., Postbus 49, Delft, The Netherlands.
SOCIEDAD DE INGENIEROS I ARQUITECTOS DE GUAYAQUIL, Casilla Correos 3442, Guayaquil, Ecuador.

* [J] denotes Junior Member.

The Society Appoints...

Announcement is made of the following appointments of Society representatives

K. B. COOK, Vice-President and General Manager, Crown Manufacturing Co., as Society representative at the inauguration of Martin James Lydon as President of the Lowell Textile Institute.

The following appointments have been made to Award Committees:

Dudley Medal Committee: R. C. PLATOW, Bell Telephone Laboratories, Inc., and DAVID WOLOCHOW, National Research Council (Canada), to serve with P. G. McVetty, Westinghouse Electric Corp.; C. E. Proudley, North Carolina State Highway and Public Works Commission; E. F. Kelley, Bureau of Public Roads; and G. M. Kline National Bureau of Standards, with Mr. Kline serving as chairman.

To the ASTM Committee on Membership

1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on membership in ASTM and include a membership application blank.

Signed _____

Address _____

Date _____ _____

Richard L. Templin Award Committee: W. A. REICH, General Electric Co., to serve with J. R. Dwyer, National Bureau of Standards, and T. Smith Taylor, United States Testing Co., Inc., with Mr. Dwyer serving as chairman.

Sam Tour Award Committee: H. A. PRAY, Battelle Memorial Institute, to serve with Russell Franks, Union Carbide and Carbon Corp., and R. B. Mears, United States Steel Co., with Mr. Franks serving as chairman.

Edgar Marburg Lecture Committee for 1952: L. J. MARKWARDT, Assistant Director, U. S. Forest Products Laboratory, *Chairman;* H. K. NASON, Assistant to the Vice-President, Research and Development, Monsanto Chemical Co., St. Louis, Mo., and O. W. ELLIS, Director, Department of Engineering and Metallurgy, Ontario Research Foundation.

A. W. TRACY, The American Brass Co., on Subcommittee on Standard Definitions of the Inter-Society Corrosion Committee, functioning under the administration of the National Association of Corrosion Engineers.

P. F. FARAGHER, Aluminum Company of America, on ASA Sectional Committee A-14 on Safety Code for Ladders.

D. HALLORAN, Consolidated Edison Co. of New York, on ASA Sectional Committee C-7 on Bare Electrical Conductors. (Mr. Halloran will serve as chairman of the Committee.)

NECROLOGY...

The death of the following members has been reported

EARL K. FISCHER, Chief, Organic Coatings Section, National Bureau of Standards, Washington, D. C. (August 3, 1951). An expert on paints and other protective coatings, Dr. Fischer had been associated with the Bureau since 1949. He had been a member of ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products.

PAUL LAWRENCE IRWIN, since 1939 Engineer of Tests, Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., died after a long illness on August 5, at the age of 52. A graduate of Carnegie Institute of Technology he did postgraduate work under Messrs. Timoshenko and Nadai. He was for several years with the Westinghouse Research Laboratories, then with other companies before his connection with Baldwin in 1938. Affiliated with ASTM since 1940 as representative of the Baldwin company membership, he was interested and active in the work of several ASTM technical committees, notably A-1 on Steel and presented numerous technical papers, several at ASTM meetings.

H. A. MARCHANT, Chrysler Corp., Detroit, Mich. Representative of his company since 1941 on Committee B-5 on Copper and Copper Alloys, Cast and Wrought, and its Subcommittee on Tolerances.

DON HULL MCCREERY, Vice-President, Quinton Engineers, Ltd., Los Angeles, Calif. (June 11, 1951). Member since 1946.

EDWARD L. MORELAND, Dean of Engineering, Massachusetts Institute of Technology, and Senior Partner, Jackson & Moreland, Consulting Engineers, Boston, Mass. (June 17, 1951). Member since 1925.

K. C. MORRICAL, Professor of Electrical Engineering, Washington University, St. Louis, Mo. (June 2, 1951). Representative of the Acoustical Society of America since 1949 on Committee C-20 on Acoustical Materials, rendering valued aid in the main group and its Subcommittee on Sound Absorption.

JOHN F. PELLY, Lubrication Engineer, Bethlehem Steel Co., Inc., Bethlehem, Pa. (July 25, 1951). Associated with Bethlehem for many years, Mr. Pelly had been instrumental in effecting many progressive changes in lubricating practices in his company. A member of ASTM since 1936, he had been active during the entire period on Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and its subgroups concerned with accelerated tests for protective coatings, and the painting of metals. He had been a member of Committee D-2 on Petroleum Products and Lubricants for a number of years, serving on the Section on Industrial Gear Oils. He also had represented his company on Committee D-10 on Shipping Containers and its subgroups concerned with methods of testing metal drums, barrels, and pallets. His other society affiliations included membership on the Committee on Packaging of the American Iron and Steel Institute.

FRANK ERWIN RICHART, Research Professor of Engineering Materials, University of Illinois, Urbana, Ill. (July 16, 1951). Member since 1918. (See accompanying article.)

HAROLD F. SAUNDERS, The Sherwin-Williams Co., Cleveland, Ohio. (July 18, 1951). Member since 1945, and representative of his company on Committee D-1 on Paint, Varnish, Lacquer, and Related Products and several of its subgroups since 1941.

E. E. WARE, Special Assistant to the President and Superintendent of Plant Construction, The Sherwin-Williams Co., Cleveland, Ohio, died suddenly of a heart attack on July 8, 1951. A member of ASTM since 1912, at which time he became affiliated with his company, he had been keenly interested in various phases of ASTM work, and active particularly in Committee D-1 on Paint, Varnish, Lacquer, and Related Products, where he served for many years and participated in the work of numerous subcommittees. He also was a member of the Cleveland District Council. He had many technical and executive responsibilities with his company. During World War I he supervised the construction and operation of a giant shell-loading plant in Illinois. His assignments with Sherwin-Williams also included Vice-President and Technical Director of the Company. Born in Shartsville, N. Y., in 1880, Dr. Ware was a graduate of the University of Michigan, and in 1943 Ohio State University recognized his outstanding work by awarding him the honorary degree of Doctor of Science.

CARLTON S. WICKER, Sales Manager, Buffalo Slag Co., Inc., Buffalo, N. Y. (May 17, 1951). Representative of company membership since 1927.

CHARLES P. WINSOR, Department of Biostatistics, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md. (April 4, 1951). Dr. Winsor had been a consulting member of ASTM Committee E-11 on Quality Control of Materials since April, 1950, serving on Task Group 8 on Smoothing Empirical Data.

To the ASTM Committee on Membership, 1916 Race St., Philadelphia 5, Pa.

Gentlemen:

Please send information on Membership to the company or individual indicated below:

_____

_____

This company (or individual) is interested in the following subjects: (indicate field of activity, that is, petroleum, steel, non-ferrous, etc.)

_____

Signed _____

Date _____ **Address** _____

Frank Erwin Richart
1892–1951

THE sudden death on July 16 of Professor Frank E. Richart came as a distinct shock to his many friends and associates in the Society, particularly those who had been privileged to be with him during the Annual Meeting at Atlantic City late in June, when he was in excellent spirits and seemed to have made real progress in his recovery from a recurrent heart condition. At that time the Society recognized his outstanding services in its behalf, and his eminence in the field of materials, by awarding him an Honorary Membership.

Since detailed biographical material was published in the July BULLETIN, which announced his Honorary Membership, it may suffice here to note that he had an extremely full and active life, and was recognized as one of the outstanding technical authorities, particularly in the field of concrete and reinforced concrete, as well as other structural materials. His major work was at the University of Illinois where he had been on the faculty since 1916 and where he became Research Professor of Engineering Materials. He had a wide variety of activities, was an excellent golfer, and had been Chairman of the Big Ten Athletic Conference.

In ASTM he had been a Director for several years, became Senior Vice-President, but declined to be considered for nomination to the Presidency because of his health.

In his death the Society loses one of its most loyal and active members who contributed greatly to many phases of its technical and administrative work. The Society records its appreciation of his notable services in its behalf, and extends to Mrs. Richart, his daughter Kathryn Mary, and his son Frank E., Jr. (a member of ASTM), its sincere sympathy.

Report of the Coordinating Committee for a National Plumbing Code

THIS report, sponsored by The American Society of Mechanical Engineers, has as its purpose the adjustment of inconsistencies among several extant codes and the selection of a series of plumbing code requirements based on actual data which would be acceptable to all parties concerned, workable and adequate for minimum safety and health requirements. The preparation of the codes has been based on experience and conclusions reached from research in the field of plumbing conducted by various Federal, state, and municipal agencies together with some universities. Such research has contributed facts which have made possible a better understanding of phenomena observed in service and which has provided a valuable basis for the development of improved code requirements.

Chapter three of this report deals with materials-quality and weight used in the construction, installation, alteration, or repair of any part of a plumbing or drainage system. This material must conform to specifications, the majority of which are listed as ASTM specifications. This material is divided into nonmetallic piping, ferrous pipe and fittings, non-ferrous pipe and fittings, and miscellaneous, which includes calking lead, sheet lead, sheet brass, sheet copper, galvanized iron and steel sheets, coal-tar enamel, etc.

Calendar of Other Society Events

"Long" and "short" calendars will appear in alternate BULLETINS. *The "short" calendar notes meetings in the few immediate weeks ahead—the "long" calendar for months ahead*

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY—September 8–9, XVIth Conference, New York City.

INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY—September 10–13, XIIth, New York City.

INSTRUMENT SOCIETY OF AMERICA—September 10–14, 6th National Instrument Conference and Exhibit, Sam Houston Coliseum, Houston, Tex.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY—September 14–15, XVIth Conference Washington, D. C.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—September 16–19 Hotel Sheraton, Rochester, N. Y.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS—September 25–28, Hotel Radisson, Minneapolis, Minn.

THIRTY-NINTH NATIONAL SAFETY CONGRESS AND EXPOSITION—October 8–12, Chicago, Ill.

THE ELECTROCHEMICAL SOCIETY, INC.—October 9–12, Annual Meeting, Hotel Statler, Detroit, Mich.

WORLD METALLURGICAL CONGRESS—October 15–19 American Society for Metals, A.I.M.E., American Welding Society, Detroit, Mich.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS—October 17–19, Annual Convention, Statler Hotel, New York, N. Y.

NATIONAL INSTITUTE OF GOVERNMENTAL PURCHASING, INC.—October 21–24, Hotel Shoreham, Washington, D. C.

PACKAGING INSTITUTE—October 22–24, 13th Annual Forum, Hotel Commodore, New York, N. Y.

THE ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA—October 22, 23, 24, Twelfth Annual Water Conference, Hotel William Penn, Pittsburgh, Pa.

AMERICAN STANDARDS ASSOCIATION—October 22–24, National Standardization Conference, Waldorf-Astoria, New York, N. Y

AMERICAN SOCIETY OF CIVIL ENGINEERS—October 22–25, Annual Convention, New York, N Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—October 22–26, Fall General Meeting, Hotel Cleveland, Cleveland, Ohio.

AMERICAN INSTITUTE OF PHYSICS—October 23–27, 20th Anniversary Meeting, Hotel Sherman, Chicago, Ill.

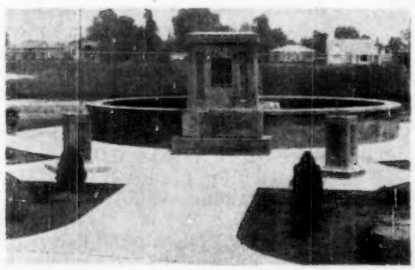
NATIONAL PAINT SALESMEN'S ASSOCIATION—October 25–27, Fourteenth Annual Convention, Hotel Traymore, Atlantic City, N. J.

NATIONAL PAINT, VARNISH AND LACQUER ASSOCIATION—October 29–31, Annual Convention, Chalfonte-Haddon Hall, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE—October 30–31, Regional Meeting, Sheraton Hotel, St. Louis, Mo.

FEDERATION OF PAINT AND VARNISH PRODUCTION CLUBS—October 31–November 3, Paint Industries' Show, Chalfonte-Haddon Hall, Atlantic City, N. J.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—December 26–31, Annual Meeting, Philadelphia, Pa.



Memorial Honors ASTM Member

The accompanying photographs show the Memorial Fountain in honor of the late Harry D. Jumper, member for several years of ASTM and active in the work of Committee C-9 on Concrete and Concrete Aggregates. Mr. Jumper was the mayor of Azusa, Calif., and the fountain is in that city's Memorial Park. The memorial was erected by his friends and associates. Mr. Jumper was for many years Chief Engineer of the Consolidated Rock Products Co. in Los Angeles. Dedication Group, l. to r.: Mayor Karl Jones; former Mayor Ray J. Lamm; Father Armando Salazar; Robert Mitchell, President, Consolidated Rock Products Co.; Mrs. Helen Jumper, Donna McClintock, Albert Jumper, Fred Jumper, and Rev. B. J. Paroulek.

NEWS NOTES ON

Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

Catalogs and Literature

Surface Testing—"Surface Evaluation by Faxfilm" is the title of a new 8-page folder describing applications and equipment for Faxfilm. Faxfilm is the process which employs a plastic replica to show roughness, wear, grain, and other surface conditions of almost any shape of a wide variety of materials. The folder describes in some detail the applications for inspection and for test and process engineering as well as applications in other fields.

The Brush Development Co., Instrument Division 64, 3405 Perkins Ave., Cleveland 14, Ohio

Coal and Coke Testing—Central Scientific Co. of Chicago have prepared a new 12-page circular listing suggested apparatus and chemicals for standard methods of laboratory sampling and analysis of coal and coke according to ASTM D 271. A copy may be obtained by writing for circular D 271.

Central Scientific Co., 1700 W. Irving Park Rd., Chicago 13, Ill.

Laboratory Apparatus—Summer edition of "Cenco News Chats" features a descriptive article on "The American Concrete Institute," with biographical notes on Arthur Newell Talbot. The apparatus section of the publication contains, among other things, descriptions of: the Wilde Soil Colloid Tester; aluminum laboratory desiccators; a midget laboratory still; and a stainless steel metering pump.

Central Scientific Co., 1700 W. Irving Park Rd., Chicago 13, Ill.

Laboratory Apparatus—The June edition of "Labitems", published by The Emil Greiner Co., contains an interesting short description of High Precision Microburets, along with a bibliography on the subject. The Catalog Supplement section of the bulletin contains a number of items of interest, including: a Ramsbottom Carbon Residue Apparatus Molten Metal Constant Temperature Bath and the new Hellige Oil Colorimeter. Among the products described as conforming to ASTM specifications are: Constant Temperature Bath for testing, pointing, and standardization of etched stem thermometers, ASTM E 77; Shouldered Rings and Ball Centering Guide, Method E 28; and ASTM Penetration Needles.

The Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.

Potentiometers—The Rubicon Co. announces a series of papers entitled "Rubicon Notes" which will provide useful information on potentiometers, resistance bridges, sensitive galvanometers, and associated instruments in their several forms for different applications. They should prove of value to all concerned with electrical standards work, electrical inspection and test, meter and recorder calibration, laboratory measurements in physics or physical chemistry, electrical methods in chemical analysis, engineering tests, or the teaching of instrumentation. The first of the series has been published and is entitled: "Semi-Precision Potentiometers."

Rubicon Co., Ridge Ave. at Thirty-Fifth St., Philadelphia 32, Pa.

Laboratory Apparatus—A new edition of "What's New for the Laboratory," No. 13 in the series, has just been issued by the Scientific Glass Apparatus Co., Inc., Bloomfield, N. J. Illustrated and described are: the Beckman Flame Photometer for Model DU Spectrophotometer, and the Krebs Constant Temperature Water Bath for use in ASTM D 445. Of particular interest is a full description, with illustrative cut, of the test apparatus for Mechanical Stability of Latex according to ASTM D 1076. Also included are descriptions of: a vertical autoclave, flexible heating tape, and an electronic temperature controller.

Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Soil Testing Apparatus—Soil Testing Services, Inc., has recently issued a 12-page illustrated, descriptive catalog of equipment which is not included in their current, illustrated brochure. Among the equipment included in the new catalog is the Soiltest frame mounted, electric loading Triaxial Apparatus. Another Consolidation Apparatus illustrated and described in detail is a high-capacity, structural steel consolidation loading frame, designed to apply a maximum pressure of approximately 52 tons per sq. ft. on a standard 100 sq. cm. specimen, but can be used for all types of consolidometers. Other pieces of equipment described are: California Bearing Ratio Apparatus; dispersion mixers; classification sets; the Terzaghi water level for differential settlement observations; compaction apparatus.

Soil Testing Services, Inc., 4520 W. North Ave., Chicago 39, Ill.

Pocket Brinell Table—A pocket-size Standard Table of Brinell Hardness Numbers for a 3000 kg load in the range from 682 B.H.N. to 93.7 B.H.N. has been published recently by Steel City Testing Machines, Inc. A copy of this card is available without cost to any interested individual who requests it on his company letterhead.

Steel City Testing Machines, Inc., 8843 Livernois, Detroit 4, Mich.

Instrument Notes

Metal Specimen Containers for Washfastness Test—Atlas Electric Devices Co. has announced that they now have available for distribution the new specimen containers for the No. 3A Tentative Accelerated Washfastness Test recently adopted by the A.A.T.C.C. This new test employing metal specimen containers, which are cylinders $3\frac{1}{2}$ in. in diameter by 8 in. in length, is said to duplicate the color destruction and abrasive action of five average commercial or home launderings in just one 45-minute test—one tenth of the time required by old test methods. Mounted horizontally, the test specimens are subjected to a forceful throw, a long slide, and a strong impact. The use of 100 steel balls in each container and a lower liquor volume ratio also serve to increase the abrasive action.

Atlas Electric Devices Co., 361 W. Superior St., Chicago 10, Ill.

New Line of Laboratory Microscopes—Ball bearings and rollers throughout the focusing system are one of the outstanding features of a new line of Laboratory Microscopes now in production at Bausch & Lomb Optical Co., Rochester, N. Y. Called "Dynoptic Labroscopes," the new instruments also feature a low-position fine adjustment and a mechanical stage with low controls that enable the operator, after setting the coarse adjustment, to rest his hand on the table and manipulate the other controls in a comfortably relaxed position. Excellent descriptive literature is available from the manufacturer.

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

Amplifier for Oscillographs—Now available is a new Direct Coupled Amplifier, designed for use in standard 19-inch rack and having a 7-inch high front panel. Designated as Model BL-962 by the maker, Brush Development Co., the instrument was designed for use with Brush Magnetic Direct Writing Oscillographs in studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures, and a-c or d-c voltages or currents. Voltage gain of the instrument, approximately 1000 times, is sufficient to give 1 mm of deflection on the oscillograph chart per millivolt input.

The Brush Development Co., Instrument Division 64, 3405 Perkins Ave., Cleveland 14, Ohio

Hardness Tester—Recently introduced in the United States is the Isoma Hardness Tester for measuring Vickers Values on small, round, and flat metal parts, foil, tinplate, glass, plastics, etc. This tester has an automatic weight-selecting device for applying dead weight loads from 50 to 1000 g. The minimum thickness of flat pieces to be tested is 0.0005 in. Minimum diameter for rounds from 0.003 to 0.005 in. Maximum distance between indenter and table is $2\frac{13}{64}$ in. The built-in optical measuring system is said to permit measuring impressions accurately to within 0.000004 in.

The Cosa Corp., 405 Lexington Ave., New York 17, N. Y.

Automatic Titrator—A new instrument said to provide precise, high speed, fully automatic titration at minimum cost, and with the least possible use of space or

time has been announced. The instrument called the "Autotrator," is said to perform automatically all the steps necessary to a perfect titrating technique. Titrant is delivered rapidly until the end-point approaches, then is restricted, the final portions being added in progressively smaller increments until the true end point is reached. Operation is controlled by the Coleman Model 18 pH Electrometer which measures and continuously indicates the progress of the titration. The Autotrator employs standard laboratory accessories and occupies a minimum of laboratory space. Coleman Bulletin B-223.

Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.

Laboratory Glassware Washer—A new laboratory glassware washer, taking six large basketfuls of labware at once—bottles, funnels, culture tubes, flasks, pipettes, Petri dishes, microscope slides—is said to deliver them thoroughly washed and rinsed, chemically clean, in a fraction of the time required by conventional "dishwashing." The operator merely loads the proper size of basket, attaches lid, and places basket on drum. The drum carries the baskets at 9 rpm Ferris-wheel fashion. Numerous small jets at one end of the tank admit hot, cold, and warm water. Glassware can thus be given hot and cold rinses as desired, and, in the steam-heated model, can be treated with live steam as well. Two models are available, a steam-heated instrument operated on either 115 or 230 volt ac, and an electrically operating instrument operated on 230 volt ac. Both have connections for hot and cold water and drains. A detailed illustrated booklet, "The Fisher Laboratory Glassware Washer," will be sent on request.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Color Comparison Tubes—Nessler Color Comparison tubes with interchangeably-ground cap type stoppers are now being made by Kimble Glass, division of Owens-Illinois Glass Co. Both stoppers and tubes have the Kimble shadowless bottom feature. The use of stoppered Nessler tubes will do away with contamination resulting from the tendency of some solutions, when exposed to air, to oxidize or form surface films. It is not necessary to remove the stopper when making readings because of the Kimble "shadowless bottom." When these tubes are filled with liquid and viewed with a light source beneath the tube, there are no dark spots to interrupt comparisons, nor will the bottom distort transmitted light. Both standard and low form stoppered Nessler tubes are made in three sizes. The low form tube is sold under the Kimble catalog number 45320 and the standard under the number 45325.

Owens-Illinois Glass Co., Toledo 1, Ohio

Infinite Life Geiger Counter—An instrument said to be the first infinite life Geiger Counter to operate under conditions of high ambient temperature has been announced by Radiation Counter Laboratories, Inc. Developed for special work, the stainless steel counter tube is filled with the infinite life mixture, argon-xenon, oxygen, nitrogen, and is cooled by a stream of water passing around the cathode. This is designated as the RCL "Phoenix" Counter, Mark 1 Model 15X. Descriptive literature is available.

Radiation Counter Laboratories, Inc., 1844 W. 21st St., Chicago 8, Ill.

"Pint-Sized" Filter Pump—A new line of pint-sized filter pump units in various models for the laboratory or plant which filters small batches of industrial solutions is announced. These units are said to be characterized by simple and economical operation. The pump, designated "Model LSU-5," can be used for either periodic or continuous filtration. The motor is $\frac{1}{15}$ hp, Universal, 110-volt a-c - d-c sleeve bearing. The unit weighs 20 lb. The dimensions are 11 by 14 by 12 in. high. The cotton filter tubes are made of specially processed cotton yarn wound around a stainless steel core. The cotton filter tubes are resistant to both acid and alkaline solutions. The filter tubes come in different degrees of fineness. According to the manufacturer, small quantities of solution as well as expensive solutions may be filtered without perceptible loss. The filter cylinder holds approximately one pint of fluid. The progress of filtration can be seen through the clear lucite cylinder.

Sethco, 105-07 150th St., Jamaica 4, N. Y.

Cupcase Thermometer—A new Cupcase Thermometer, narrow enough to fit into two-inch gage pipes in oil storage tanks is announced by TAGliabue Instruments Division, Weston Electrical Instrument Corp., Newark, N. J. It is designed for use in the oil industry where temperature is an important factor in determining the volume of oil at the time of sale. Known as TAG Model 8652, the new thermometer has a cup capacity of 100 ml. The thermal inertia resulting from this larger capacity provides greater resistance to temperature change as the thermometer is raised from reading depth and passes through varying temperatures at other levels. The new Cupcase thus permits accurate volumetric corrections for readings above or below 60 F., the sale price temperature. Said to meet all ASTM specifications, Model 8652 has a bulb positioned $\frac{5}{8}$ in. from the nearest wall of the cup and almost centered to provide the greatest possible lag. Made of nonsparking metal, the cup measures $1\frac{3}{4}$ in. in diam. Over-all length of the instrument is 16 in. It is available in two scale ranges: one from 0 to 180 F., (ASTM 59 F – 48 T) and the other from —30 to 120 F. (ASTM 58 F – 48 T). Both scales have 1 deg graduations.

TAGliabue Instruments Division, Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

INSTRUMENT COMPANY NEWS . . . .

Announcements, changes in personnel, new plants and locations, and other notes of interest

Applied Research Laboratories. Marking the first step in a major expansion program for Applied Research Laboratories, manufacturers of spectrochemical equipment, 4336 San Fernando Rd., Glendale, Calif., the completion and occupation of a new plant has been announced by M. F. Hasler, President. Located at 3630 San Fernando Rd., the new plant houses the Company's Quantometer Instrument Division and is for the exclusive manufacture of ARL Quantometers and source units for production control and industrial research.

Burroughs Adding Machine Co. has announced the acquisition of Control Instrument Co., Inc., Brooklyn, N. Y., designers and manufacturers of electronic instruments and fire control devices for the U. S. Navy. Control Instrument Co. will continue, as a separate corporation, to use its facilities for defense production in this field. Mr. John J. Hyland will continue as President of the company.

Central Scientific Co. Two scholarships for graduate study in physical sciences have been awarded by the Central Scientific Co. for the academic year 1951–1952. The recipient for scholarship at the Master's degree level, is Mr. Edwin F. C. Cain, who will continue his graduate research work in chemistry at Michigan State College. The predoctoral scholarship was awarded to Mr. Josef Anton Hofmann, who has been accepted as a candidate for a degree of physics at Harvard University.

Consolidated Engineering Corp., of Pasadena, Calif., has recently published a supplement to their regular publication "CEC Recordings" for June, 1951. The supplement is entitled: "Welcome to Consolidated Engineering," and gives a complete description of the operations of this organization largely through a pictorial trip through their new plant. Covered in the brochure are: a history of the organization and the development of its products, administrative setup, engineering and research facilities, manufacturing facilities, and methods. The firm is widely known for its work in mass spectrometry. The publication "CEC Recordings" contains two articles of interest entitled, respectively: "Northwestern University Studies Distribution of O^{18} in Air with Modified Mass Spectrometer," and "Mass Spectrometer Design Factors." Also included is a comprehensive bibliography on recent articles on mass spectrometer applications.

Fisher Scientific Co. To head its expanding facilities Fisher Scientific Co. has recently appointed Dr. Samuel W. Levine as Director of Development. A researcher in X-ray and emission spectroscopy, the properties of petroleum reservoirs, and hydrocarbon thermodynamics, he was also active in the development of pioneer microwave radar systems in World War II at the Massachusetts Institute of Technology Radiation Laboratory.

The Posey Iron Works, Inc., of Lancaster, Pa., has been granted trade registration of the name "Lancaster" by the U. S. Patent Office. This trademark covers a wide variety of equipment manufactured by the Posey Iron Works, Inc., including batch mixers, automatic brick-forming machines, pallet car loaders and its full line of clay processing equipment.

Scott Testers, Inc. As a result of the annual meeting of Scott Testers, Inc., held in Providence, June 15, 1951, the following officers were announced: The newly elected president is David C. Scott, Jr., who also continues as sales manager.

James M. Scott continues as treasurer and production manager. Diana Scott Worthington becomes secretary. William G. Ahlson, who for some time has been accountant of the firm, is assistant treasurer. Other executive personnel remain as before Harold W. Horton, general sales engineer; Harald R. Rasmussen, in charge of sales, research and development of the Mooney Viscometer division; Enoch B. Bolton, factory superintendent; Robert W. Rogers, chief engineer.

Tracerlab, Inc., W. E. Barbour, Jr., president of Tracerlab, Inc., has announced that the Kelley-Koett Manufacturing Co., Cincinnati, Ohio, a Tracerlab subsidiary, has been appointed exclusive distributors of the high voltage X-ray equipment for medical therapy and industrial radiography produced by High Voltage Engineering Corp., Cambridge, Mass.

Dr. Edward U. Condon Appointed New Director of Research, Corning Glass Works

ANNOUNCEMENT has been made of the appointment of Dr. Edward U. Condon, noted nuclear physicist, as director of research and development of Corning Glass Works. The announcement was coincident with the acceptance by President Truman of Dr. Condon's resignation, effective September 30, as Director of the National Bureau of Standards, Washington, D. C.

The announcement stated that the appointment of Dr. Condon to direct Corning Glass Works' broad research and development activities is another step in the maintenance of the company's position as a leader in glass research and the manufacture of technical and consumer glassware. It was also noted that Dr. J. T. Littleton, vice-president and until now director of research and development, will become general technical adviser. In this capacity he will be available to all departments of the company and its subsidiaries for advice on technical problems.

Corning Glass Works, with Dr. Littleton as its representative, has been a member of ASTM for many years.

Materials Shortages

AN ARTICLE appearing in the July issue of *Materials and Methods* deals with a timely and serious subject "How to Overcome Materials Shortages." This article is intended to help those who are faced with this problem by bringing together in one place the following information: Ways and means of overcoming shortages; suggestions on conserving or replacing specific scarce materials; where and how alternate materials can be used; case histories describing how some leading manufacturing companies are licking the shortages problem, and a reference table listing specific alternate materials for specific products.

Meeting Defense Goals

UNDER the title "Meeting Defense Goals, A *Must* for Everyone," Charles E. Wilson, Director, Office of Defense Mobilization, on July 1 made his Second Quarterly Report to the President. Some of the material stressed in that report (bold-face type from the report) is noted here.

The Mobilization Pattern Takes Shape. Three Areas of the Free World Are Critical

As we and our partner nations now tackle the difficult problem of controlling and distributing our resources, all of us must remember the fundamental fact that the free world is being menaced as a whole and that it must respond as a whole.

In the build-up of free world strength, there are three critical areas:

1. *Western Europe*—where the object is strength in being, mobilization, capacity, and political stability sufficient to deter the Soviet Union from attempting to seize a center of industrial power second only to that of the United States.
2. The nations of the *Middle East and Asia* outside the Communist world—where the object is a state of political and economic health which will strengthen each nation internally against the threat of Communism and enable it to make its maximum contribution to the common defense.
3. *The Western Hemisphere*—where the object is a tremendous development of military and economic strength not only to serve the defense of this area but also to provide a central source of support for defense efforts among all free countries.

Progress toward military and economic power in Western Europe has been substantial in every way in which such power can be measured—higher military budgets, greater production, more men in service.

Vital Materials

In some cases, there simply are not enough raw materials now being produced in the world to support all of the essential needs of all free countries.

In the case of supplies which we control, we are willing to share where sharing is needed.

Questions as to what is "equitable" as among the requirements of all consuming countries will have to be faced and answered constantly as long as shortages continue to hamper the defense mobilization of the free world.

Inflation

Our price control policy must be both firm and flexible. We will not hesitate to make price adjustments promptly where the case for them is clear. But if we do not achieve stability of the price structure as a whole we shall not have the freedom to make needed adjustments. An aimless upward drift of prices would serve no useful purpose whatever.

Freedom Gains Strength

The threat of Communist aggression can be countered if the nations of the free world marshal their physical and spiritual resources. Collectively, the countries outside the Communist bloc possess a superiority in all the factors that go into economic strength—skilled manpower, raw materials, and capacity to produce. Events since Korea have demonstrated their will to defend their freedom and hold back the forces of enslavement.

Meeting Goals Demands National Unity

No one in this Nation believes more firmly in our free economy than I do. No one has less liking for controls. But during the defense period, we cannot permit economic forces to operate with their normal freedom.

But there is no room for patience in dealing with the man or the group whose complaint is simply that he lost his opportunity to gain at the expense of the rest of the country.

And the program must go forward with the same force whatever happens in Korea. The assault by Soviet Communism in that corner of the globe was but an episode in the long-term struggle in which we are engaged.

If a truce is reached in Korea, or even if peace is fully restored in that country, new aggressions are always possible anywhere along the broad perimeter of the Soviet empire, and any of these could lead to a global war. We dare not slacken the pace of defense mobilization until the strength of the free world is sufficient to meet any attack.

Copies of the complete report available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 30 cents a copy.

Advice from One Who Knew

FIRMLY chiseled in the beautiful wooden pedestal supporting the bust of Alexander Graham Bell in the lobby of the Bell Telephone Laboratories Building at Murray Hill is a thought-provoking statement from this genius who contributed so much to our comfort and scientific advancement. Here it is:

"Leave the beaten track occasionally and dive into the woods—you will be certain to find something that you have never seen before."

Some Recent Observations in Micro-Hardness Testing*

By E. Börje Bergsman[1]

THE growing interest displayed in micro-hardness testing during the past few years is proved by the large number of technical papers published on the subject. These papers either outline new types of micro-hardness testers or deal with fresh experience gained and problems encountered in the application of the method.

There are many reasons for the increased interest in the method. The most important is that the method has made it possible to measure the hardness of objects and materials which previously were beyond the scope of hardness testers, as for example, very small specimens, thin surface layers, foils, brittle materials, welds, cold-worked parts of a specimen, and the individual grains of a microstructure. The method also enables one to study diffusion processes and crystallic segregations and has been used in mineralogy (**1, 2, 3**)[2] and dental technology (**4**).

A further reason for the increased interest in the method lies in the greater insight it gives into the complicated problem of hardness. The enthusiasm of some authors, however, has undoubtedly been too great, leading them to draw conclusions too quickly.

Since some contradictory results have been published, it is important that further studies be made of the factors influencing the results of micro-hardness testing. The results of some investigations made in the laboratory of the Munkfors Works of the Uddeholm Co., Sweden, have been published earlier (**5**). These investigations have since been continued, and the present paper deals primarily with these later results. One of the main problems encountered is the question of the load-dependence of the hardness number, which is extremely important from many points of view. This question will in turn lead to consideration of the interesting and as yet not wholly explained question of elastic recovery after making the hardness indentation.

Study of Factors Influencing Micro-Hardness Testing

Calibration with a "Siegbahn" Spectroscopic Grating:

An outstanding problem of micro-hardness testing is the calibration of the optical system used. This calls for a great deal of work, because the reliability of results of measuring the dimensions of the indentation is naturally dependent on how accurately the calibration has been performed. The importance of the accuracy of measurement is especially clear when it is kept in mind that the hardness number is inversely proportional to the square of the impression diagonal.

A proof of the necessity of doing something on this score is seen in the result of a comparison performed with a series of micro-Vickers impressions in hardened steel. The impressions were made at Munkfors with a Bergsman micro-hardness tester (**6**) with loads of 500, 200, 100, 50, and 25 g, and were measured both at Munkfors and in some American laboratories. The results have now been received from two American laboratories and are given in Table I.

The question of correctness of the values presented will not be discussed here; it can be noted, however, that the agreement between the values is acceptable in certain cases, especially for the larger impressions (approximately 30 μ). For the smaller ones (approximately 7 μ) the greatest deviation was about 7 per cent, which is rather serious.

For calibration purposes, an ordinary stage micrometer is commonly used consisting of a scale graded on a metal surface, where 1 mm is divided into 100 divisions. These stage micrometers are intended for determining the magnification in the microscope and they therefore call for only moderate accuracy. A more accurate calibration method is necessary for the following reasons:

1. The stage micrometers are too coarsely grated. Whether sight is taken at one edge or the other of the grated line it is difficult to get an accurate measurement.

2. Stage micrometers of different manufacturers do not always give results that agree. Therefore it has been impossible to base these investigations on any commercial stage micrometer.

It is known that gratings for spectro-analytical purposes (optical gratings) possess a very high degree of accuracy. The spacing of lines of these gratings, however, is in general too fine for adapting them to calibration purposes.

Optical gratings of very high accuracy are made in Sweden at the Nobel Institute of the Royal Academy of Sciences in Stockholm. The Institute owns two grating machines, one for 576 and one for 1400 lines per mm. The first of these machines could be adjusted for 288 and 144 lines per mm, which was considered suitable for the present investigation.

A calibration grating was specially made by Prof. M. Siegbahn, head of the Nobel Institute. In addition to its high accuracy (the line space has a tolerance of 0.01 to 0.001 μ), this special grating has proved to possess the following advantages over the ordinary stage micrometers:

1. The finer spacing (288 lines per mm) has been found especially suitable for calibrating for small Vickers impressions. The coarser spacing is more advantageous for calibrating when larger impressions are considered.

2. The Siegbahn micrometer was grated in four groups of lines, with gradually increasing load on the grating diamond. This enables a better adaptation to the optical system used.

3. The lines are finer and thus facilitate a more exact setting of the measuring rideaux (or hair lines) than is possible with the ordinary stage micrometers.

A comparison between the appearance of two kinds of gratings is given in Fig. 1 at approximately 1030 × magnification.

In the Siegbahn stage micrometer, as seen in Fig. 1, there are well-defined "grooves" which may be projected more

TABLE I.—LENGTHS OF DIAGONALS OF MICRO-VICKERS IMPRESSIONS IN HARDENED STEEL.

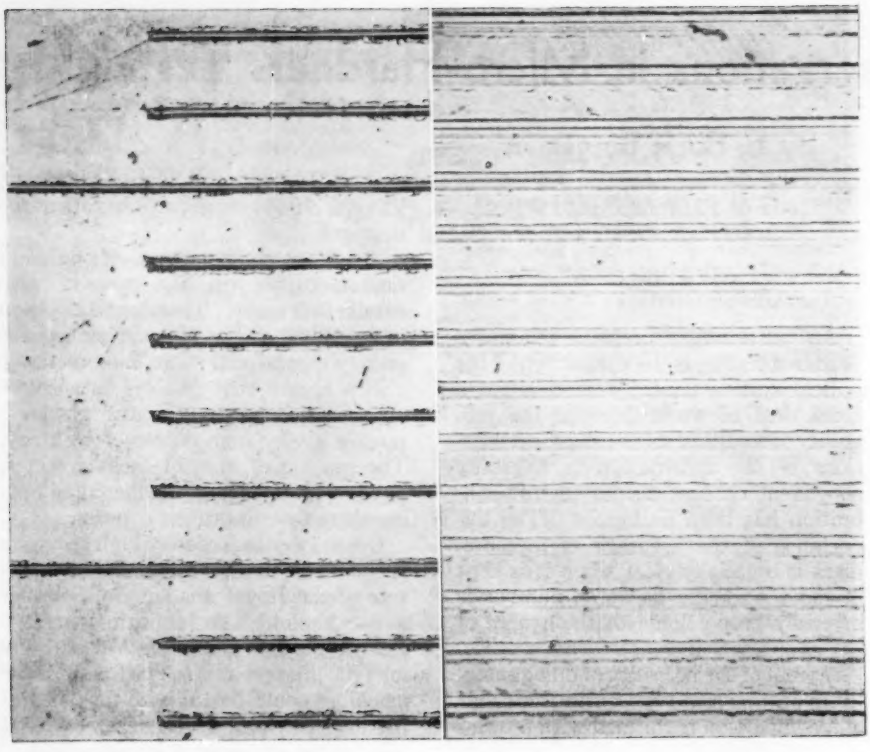
Indentation Load, g	Uddeholm Co.	American Laboratory I		American Laboratory II	
	Length of Diagonals, μ	Length of Diagonals, μ	Deviation from Uddeholm, per cent	Length of Diagonals, μ	Deviation from Uddeholm, per cent
500.....	32.02	32.09	+0.2	31.55	−1.5
200.....	20.07	20.12	+0.3	20.23	+0.8
100.....	14.07	14.12	+0.4	14.15	+0.6
50.....	9.69	9.85	+1.7	9.92	+2.4
25.....	6.72	6.88	+2.4	7.17	+6.7

NOTE.—DISCUSSION OF THIS PAPER IS INVITED either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Translated from the Swedish original by W. A. Olsen, Vice-President, Uddeholm Company of America, Inc., New York, N. Y.

[1] Chief Metallurgist, AB Svenska Metallverken, Vasteras, Sweden; formerly with the Uddeholm Co., Munkfors Works.

[2] The boldface numbers in parentheses refer to the list of references appended to the end of this paper.



(a) An ordinary stage micrometer. (b) A Siegbahn stage micrometer, 144 lines per mm.

Fig. 1.—Comparison of Gratings Between an Ordinary Stage Micrometer and a Siegbahn Stage Micrometer (× 1030).

sharply against the measuring rideaux or the hair lines than when using an ordinary stage micrometer.

One ocular screw micrometer of the rideaux type was calibrated in combination with three objectives (one dry objective and two oil-immersion objectives) in a metallographic microscope. In connection with the calibration, the identification numbers of the different optical parts were put down, as well as all data concerning illumination, filter, shutter, etc. Precautions were taken at the subsequent measuring of the Vickers impressions to ensure that all these factors were identical.

Five observers took part in the calibrating work, each of whom took five readings. The readings were then repeated with a time interval of, in general, one day. In certain cases a number of such measurements were performed. Precautionary measures were taken against erroneous readings in the calculation of the mean value by using frequency diagrams and eliminating too high or too low values. Figure 2 gives a calibration curve from one of the measuring systems used. Each value represents an average of at least 50 readings, and in some cases up to 135 readings.

The remarkable thing is that the measuring factor, as shown in Fig. 2, is not a constant, being smaller for small distances than for larger ones. This can be attributed to some irregularity in the measuring system. The cause is a constant, small deviation at the zero-point. The measuring rideaux in the ocular micrometer are situated in different planes and have to overlap to prevent any light to be seen. The error has a great influence at low ocular readings but decreases at higher. The practical consequence of the measuring factor's being a constant over the whole range may be illustrated by the following example.

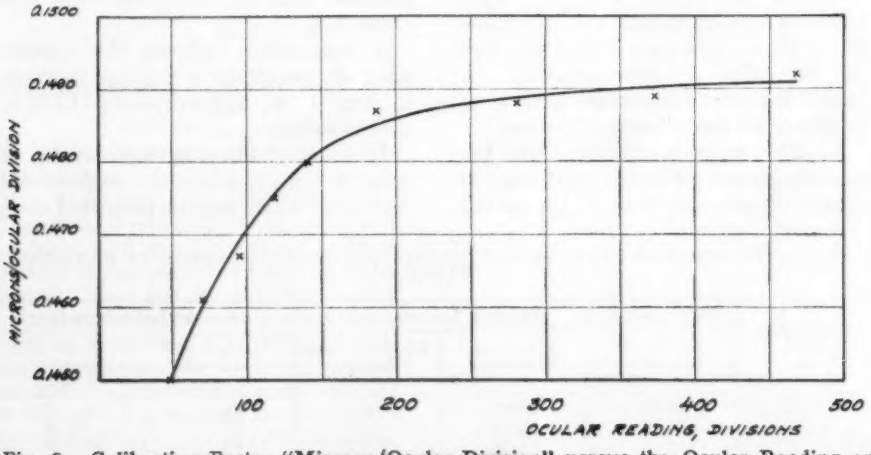


Fig. 2.—Calibrating Factor "Microns/Ocular Division" *versus* the Ocular Reading or One of the Measuring Systems Used.

It is assumed that the hardness of a specimen shall be determined with such a load that the impression amounts to approximately 10 μ, corresponding to approximately 70 ocular readings. The measuring factor in this case will then be 0.1460 μ per ocular reading. If the calibration had been performed with about 200 ocular readings, the factor would have become approximately 0.1490 μ per ocular reading. With this latter factor the diagonals in the 10 μ impressions would have turned out 0.1490−0.1460 or 2 per cent longer, which in turn would have given a hardness number approximately 4 per cent too low. Instead of obtaining a Vickers hardness of 900, one would obtain a hardness of 860, a difference that even from a practical point of view is of importance.

The consequence is that a calibration with an accurate and suitable stage micrometer in the whole range of measurements is necessary for precision work.

Importance of Loading Speed:

After the calibration had been completed, a test was performed to determine the effect of the loading speed on the hardness number. This was applied first to the micro-hardness tester, previously described (**6**), and second, to a Vickers hardness tester, constructed by the author for testing with loads above 500 g. The load range is 500 to 5000 g, and the indentation loads are obtained by direct loading. (See Figs. 3 and 4).

The effect of speed was investigated at three different indentation loads, namely 25, 200, and 2000 g. The specimen was hardened carbon steel with 0.87 per cent carbon, tempered at 500 C.

Figure 5 shows the results of the test. Effect of the indentation speed is most noticeable at the smallest load (25 g) which is to be expected since the dynamic effect should play a larger rôle here than at higher loads. It is consequently necessary to take the indentation speed into consideration, and to meet this condition a drive device was prepared that produced an indentation speed of 0.04 mm per min, which was used for the subsequent tests. According to experience gained in practical testing it has not been necessary to use a special drive device in order to obtain a usable indentation speed. A certain

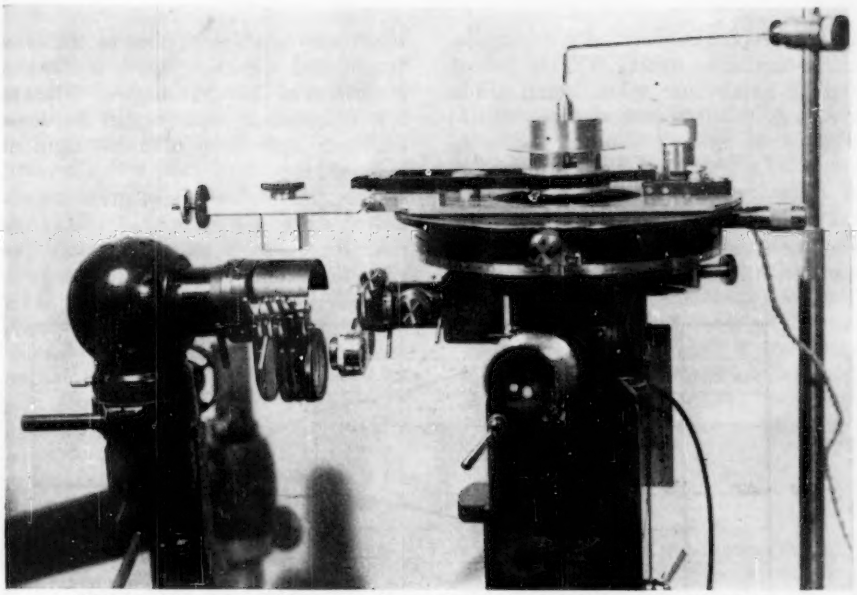


Fig. 3.—Bergsman Micro-Hardness Tester (6) Load Range 0.5 to 500 g.

acquired practice of correct testing is sufficient. A faulty practice is at once evidenced by too low values and an abnormal deviation of the hardness numbers.

Required Contact Period:

In addition to the indentation speed the time of contact needs to be considered. According to generally accepted practice 15 sec seems to be the time most widely used. A shorter contact period, however, would be desirable not so much from the saving of time but for the reason that micro-hardness testing is very sensitive to vibrations. If the hardness testing time can be shortened the risk of error due to incidental vibrations will be minimized. This consideration was regarded as so essential that a special study was made of the required contact period on three different kinds of steel, hardened steel, 18–8 steel, and soft iron. On these materials it was found that the duration time can be shortened from 15 to 5 sec, or even less. It is recommended, however, that everyone faced with the same problem when testing other materials should investigate whether a shortened time of contact is permissible. It is possible that a fully developed impression will not occur in all materials in 5 sec.

The fact that a contact period shorter than 15 sec is permissible agrees with data in the booklet furnished with Hanemann's micro-hardness tester (24).

Risk of Vibrations:

That vibration is the *bête noire* of micro-hardness testing has been pointed out earlier by many investigators (5, 7, 8, and others) but it is so important that it is emphasized again. This fact has still not been clearly realized by all those engaged in micro-hardness testing. In all chemical laboratories it is understood that analysis scales must be carefully protected from vibration. Similar precautions must be taken in the metallographic laboratory with regard to the micro-hardness tester. If this is neglected the measuring results will hardly be of any value.

Preparation of Specimens:

It is now generally recognized that the preparation of the specimen to be tested has a great influence on the result of a micro-hardness test. This is easy to understand especially for materials which are known to harden when cold-worked—for instance, materials such as aluminum, copper, iron, austenitic steel, etc. The necessity of exercising care also in the preparation of specimens of harder materials is shown by the following example:

Two specimens of a plain carbon steel with 0.96 per cent carbon were ground on emery paper to number 000. The specimens were then hardened from a temperature of 775 C and tempered at $\sqrt{100}$ C for 10 min. After hardening and tempering, the two specimens were ground on stationary paper Nos. 2, 1, 0, 00, 000. One of the specimens was subsequently polished mechanically and the other electrolytically. The result of micro-hardness tests is reproduced in Fig. 6.

The black dots and squares show the values obtained from measuring with Leitz 2-mm objective, the others from measuring with a Leitz 1/7a objective.

It can be seen from Fig. 6 that the influence of the specimen preparation is very pronounced.

Whether the result shall be interpreted as the effect of cold-working is a subject of discussion. Other changes in the surface layer are also possible. Wiester (9) has pointed out that the surface layer under certain conditions can undergo important chemical changes. After the grinding of iron and steel specimens, he found it possible to

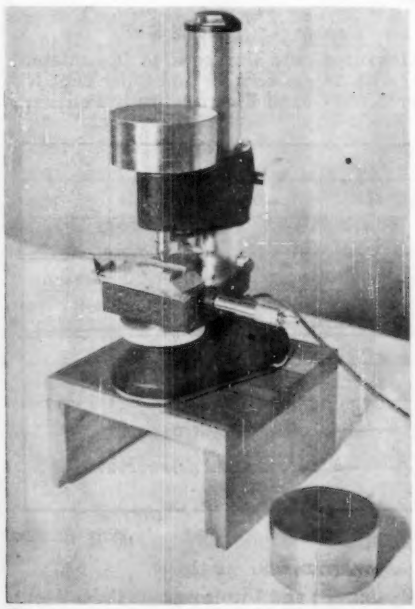


Fig. 4.—Directly Loaded Hardness Tester for Loads Between 500 and 5000 g.

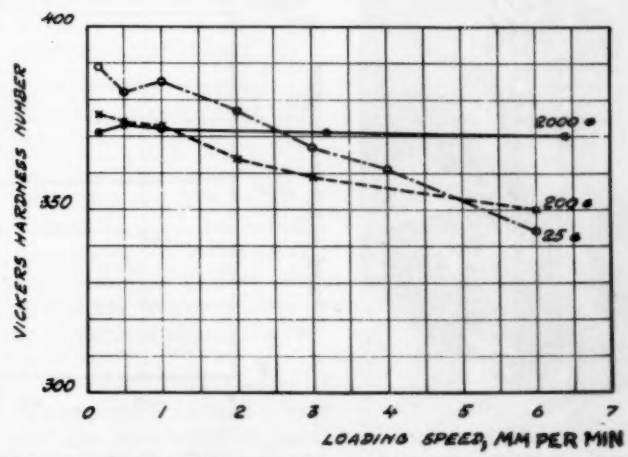


Fig. 5.—Effect of the Indentation Speed on the Hardness Number at Three Different Indentation Loads (25, 200, 2000 g). The Impressions Made in the Hardness Testers According to Figs. 3 and 4. Hardened and Tempered Steel with 0.87 per cent C.

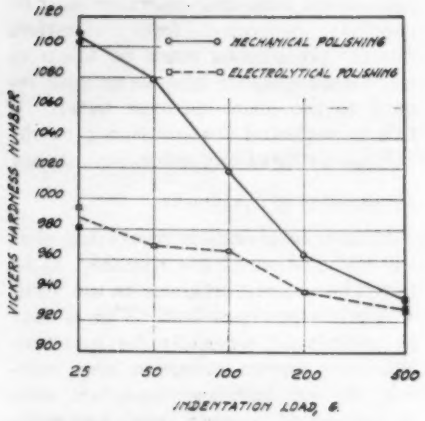


Fig. 6.—Influence of the Specimen Preparation on the Hardness Number at Some Indentation Loads. Testing of Hardened Steel Tempered at 100 C, 0.96 per cent C.

detect a significant increase of the nitrogen concentration in the surface layer. This absorption of nitrogen was assumed to be connected with the increase of temperature in the specimen, due to grinding, which enabled the surface to dissolve nitrogen. That absorption of nitrogen should cause an increase in hardness in the surface layer seems natural. It appears then that in the given example more metal is removed by electrolytical polishing than by mechanical polishing. Through separate tests it has been shown that electro polishing in the apparatus used and described in reference 10 removed approximately 12 μ thickness of surface, and the mechanical polishing approximately 2.5 μ. Whatever the explanation, Fig. 6 shows that great care must be taken in the preparation of the specimen in micro-hardness testing. This is of special importance when small loads are used.

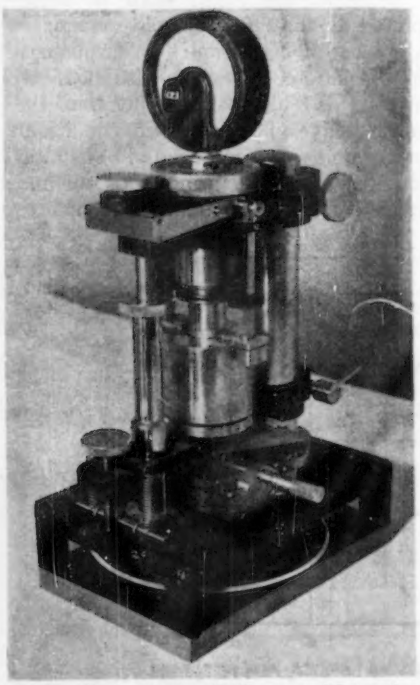


Fig. 7.—Indentation-Difference Meter for Measuring Impression Depth Under Load and After Unloading.

Effect of Load on the Hardness Number

Consideration of Fig. 6 brings up another question, namely, the effect of load on the hardness number. The lower curve, which applies to the electropolished specimen, gives a distinct indication of load dependence. Thus at low indentation loads higher hardness numbers have been obtained than at heavier loads.

This circumstance is of great importance, since the practical utility of micro-hardness testing is connected with the extent to which the hardness

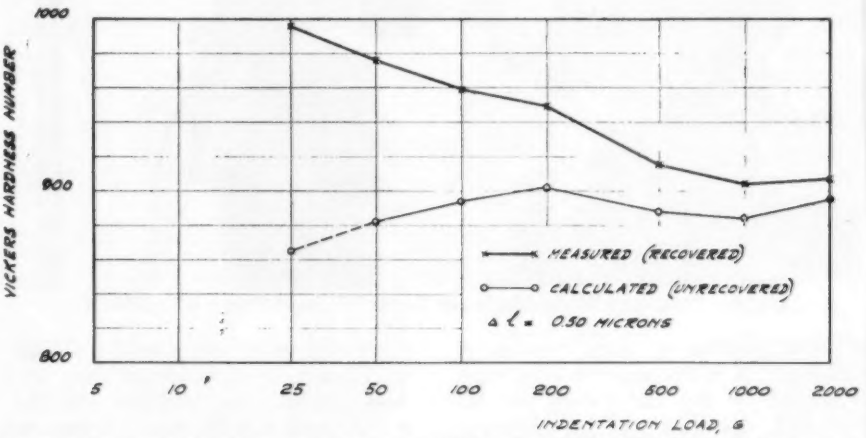


Fig. 8.—Hardness Numbers from Recovered (Measured) and Unrecovered (Calculated) Vickers Impressions. Carbon Steel 0.96 per cent C, Hardened from 775 C, 10 Min, Quenching in Water, Tempered at 100 C, 10 Min. Electrolytically Polished.

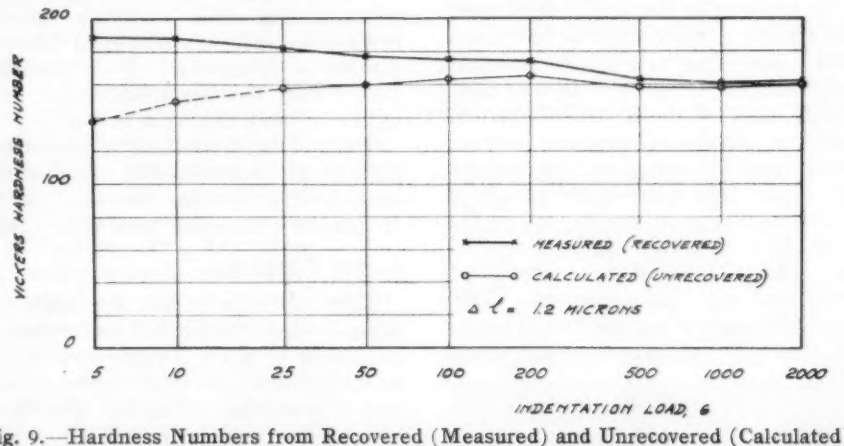


Fig. 9.—Hardness Numbers from Recovered (Measured) and Unrecovered (Calculated) Vickers Impressions. Austenitic Stainless Steel with 18 per cent Cr and 8 per cent Ni. Polished and Afterward Soft Annealed in Vacuum (1.050 C) and Electrolytically Polished.

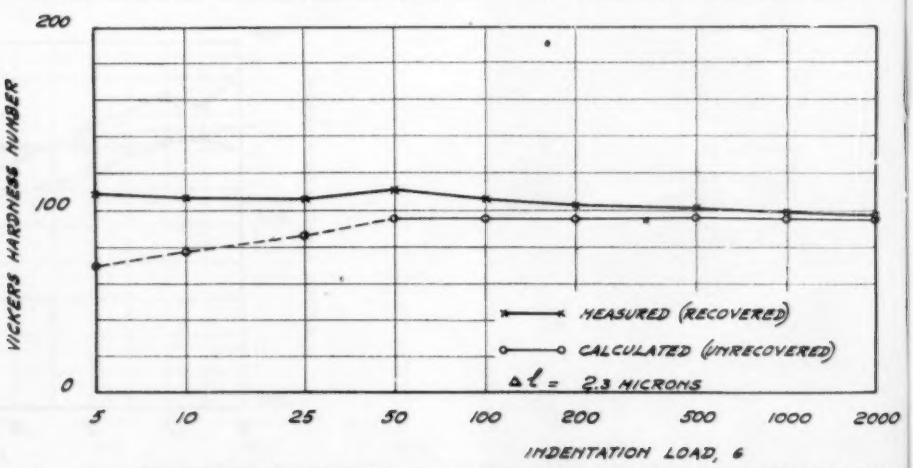


Fig. 10.—Hardness Numbers from Recovered (Measured) and Unrecovered (Calculated) Vickers Impressions. Low-Carbon Iron (0.05 per cent C). Polished and Afterward Soft Annealed in Vacuum (700 C) and Electrolytically Polished.

number is affected by the load. An exact knowledge of the effect of load on the hardness number is necessary for drawing safe conclusions from the tests.

Published investigations by the German authors Hanemann, *et al.* (11), Bernhardt (12), Bischof and Wenderott (7), and the American Knoop, Peters and Emerson (13), Tate (14), Thibault and Nyqvist (15), and Brodie (23) show agreement. All of them have found a load dependence in the direction indicated by Fig. 6. A similar result was arrived at by the Austrian Onitsch (2).

An investigation by Campbell, Henderson, and Donleavy (17), however, gave results contrary to those of the above-mentioned authors; with decreasing load they obtained decreasing hardness numbers.

Bergsman (5) also found a load dependence in soft-annealed 18–8 steel and soft-annealed iron which agrees with the results of Hanemann and others. In the testing of some other materials, however, hardness numbers were obtained which were unaffected by the indentation load.

Because of the contradictory results it was considered desirable to carry out a special investigation on this point. New tests were made, with the highest possible accuracy on hardened steel (that is, martensite), on soft-annealed 18–8 steel, and soft-annealed iron. The calibrating factors obtained with the aid of the Siegbahn grating were used, and advantage was taken of the practical experience already gained.

In brief, the new tests have confirmed that decreasing indentation loads give increasing hardness number. Better correspondence has thus been achieved with all the authors mentioned except with Campbell, *et al.* The test results are reproduced in Figs. 8, 9, and 10.

Apart from the consequences of the effect of load, which sometimes is of practical importance, the question is also of theoretical interest. Many authors have dealt with the question and, in the main, two interpretations have resulted. No consideration is given here to the explanation sometimes offered, that the preparation of the specimens would influence the result. This source of error has been clear to most of the authors and has been eliminated in one way or another.

One of the interpretations of the load dependence, which on the whole has been accepted by German authors (11, 12, 18) and also by some Americans (19), is that Meyer's analysis (20) is applicable to the Vickers test. The other interpretation is that the elastic recovery upon release of load plays a part.

Meyer's Analysis for Explaining the Load Dependence:

The application of Meyer's analysis to the Vickers test in order to explain the load dependence must be regarded as incorrect. The fact that Meyer's analysis applies only to spherical indenters, such as in the Brinell test where there is no geometric similarity at different impression depths, should invalidate its adoption in Vickers testing.

Further proof that the explanation is not correct is provided if the consequences of the erroneous application of Meyer's analysis are drawn, as follows:

Meyer's equation (for a ball-shaped indenter) is

$$P = a \times d^n \ldots\ldots\ldots\ldots (1)$$

where:

P = load in kg,
d = diameter of indentation in mm,
a = a constant, dependent on the properties of the material tested, and
n = a constant, dependent on the capacity for cold work of the material.

The exponent n is thus a measure of the capacity for cold work; if $n > 2$ the material is characterized by the hardness increasing from cold-working.

Now, if Meyer's analysis is applied to the Vickers test, there will be such a load dependence at micro-hardness testing as to produce $n < 2$, which would signify that the material in question becomes softer after cold-working. Practical experience of course shows the contrary to be the case. Onitsch (2) has even been able to show that the exponent n has certain values in micro-hardness testing and others in macro-hardness testing. This would result in a distinction between the conception of micro-hardness and macro-hardness. Such a distinction is artificial and does not exist in reality.

The applying of Meyer's analysis therefore cannot be used for explaining the load dependence. This was pointed out earlier by Bergsman (5), pp. 604, 605.

The other explanation of the load dependence is that it is caused by elastic recovery after releasing the load.

Elastic Recovery and Its Significance for Interpreting the Load Dependence

The significance of elastic recovery in hardness testing has been the subject of much discussion. So far no definite solution has been given. This is a fundamental question and no type of hardness testing has any real foundation so long as the question of elastic recovery remains unsolved.

Probably no better illustration is given of this problem than that offered by the now classical example of hardness testing of rubber. If an attempt is made to determine the Vickers hardness of a piece of rubber in the customary way, it will be found that the diamond indenter does not make any measurable impression. The logical conclusion would then be that rubber is at least as hard as diamond, which of course is absurd. The great elasticity of rubber and the resultant recovery are responsible for obliterating the impression.

On the other hand, it is known that metallic materials possess many variants of hardness and elasticity. Hardened steel possesses both great hardness and high elasticity. Annealed aluminum is soft and has low elasticity. There are also examples of materials which are hard and have a low elasticity, and those which are soft and have a high elasticity.

The objection that can be raised against the most commonly employed hardness testing methods—Brinell, Vickers, Rockwell, etc.—is that only the size of the permanent or plastic deformation is obtained. Although the conception of hardness is a very complex problem, and the hardness number is not a real material constant, it might be possible to gain better information about materials if the hardness test could determine the sum of the elastic and the plastic deformation. The hardness numbers obtained on this basis would then in most cases be smaller than those now obtained. The amount by which they are decreased would then be a measure of the elastic deformation.

It would naturally be an advantage, if it were possible by means of direct determinations, to obtain a hardness number that included both the elastic and the plastic deformation. At first sight it seems possible to reach this goal through depth measurements under load and after unloading. The impression depth obtained under the former condition would then correspond to the hardness number looked for, whereas the impression after unloading would represent merely the amount of the plastic deformation.

Devices for the application of this principle have been described earlier (7). They do not seem, however, to have been used to any great extent. Nevertheless, the idea was considered worthy of further study and an indentation-difference meter was built, as shown in Fig. 7.

The indenter is a Vickers diamond and the measuring device is a special Microkator as described by Abramson (21). Each division represents 0.1 μ depth of impression.

A minor load of 100 g provides the reference level. The main load applied subsequently was 1900 g, the total load being thus 2000 g. By direct measurements after each test it was possible to

determine and to make corrections for the unavoidable resilience in the device.

Tests were made on hardened steel of different tempers. It was found that the elastic recovery in the impression depth after unloading amounted to almost 30 per cent for the hardest specimen, with a Vickers hardness number of 890, and 8 per cent for the softest specimen with a Vickers hardness number of 175.

The measurements thus showed that martensite is both hard and elastic, which was known before. The results are in full agreement with those earlier obtained by Bischof and Wenderott (**7**).

The question is whether it is permissible to base the hardness number on the impression depth under load—that is, the hardness number which should show the sum of the elastic and the plastic deformation.

This can only be settled by determining the actual size of the impression under load. To do this a method was tried, which has also been used before (**7, 22**). Before the indentation was made, the Vickers diamond was coated with ammonium chloride[3] which was allowed to sublimate and deposit on the diamond. The length of the upper edge of the part of the diamond that had been in contact with the steel was then measured. Difficulties arose in securing a thickness of the ammonium chloride layer that would permit the desired accuracy of measuring. It could nevertheless be ascertained that the recovery, if any, could not be of such amplitude as that indicated by the depth measurements. The explanation of the great recovery measured must therefore be, at least in part, that the regions around the actual impression are also depressed elastically.

The efforts to arrive at a more correct hardness number than the usual one through direct determination by the indentation depth meter were thus unsuccessful. The measurements had not, however, given any proof that the elastic recovery did not exist. The ammonium chloride tests showed only that the elastic recovery in the impression diagonal, if any, must be very small. An improved technique was therefore required.

It appears possible to throw light on the question by means of the following approach.

Tate's, Tarasov's, and Thibault's Interpretation of the Load Dependence and of the Part Played by Elastic Recovery:

Tarasov and Thibault (**16**) have given a theoretical interpretation of the experimental data published by Thibault and Nyqvist (**15**), who determined the hardness of certain hard materials with a Knoop indentation diamond. The softest material tested was hardened steel of about 60 Rockwell C, the hardest was boric carbide. By using different indentation loads Thibault and Nyqvist could ascertain very pronounced load dependence. Higher hardness numbers were obtained at low loads than at heavy loads.

In their theoretical interpretation Tarasov and Thibault followed a line of thought, which had also been presented earlier by Tate (**14**), namely: proceeding from the fact that the form of the impression is independent of the indentation load and size of the impression, it is assumed that the stress distribution around the corners of the unrecovered impression should be the same no matter what the load. Since the stress distribution ought to be the factor that determines the elastic recovery, the amount of the elastic recovery should be independent of the indentation load.

The consequence of this assumption is that it should be possible to obtain the diagonal length of the unrecovered impression by adding a constant correction length Δl to the measured diagonal length.

The length Δl can be obtained according to the following calculations:

The measured (recovered) hardness number H_m is, as is well known

$$H_m = k \times \frac{P}{d^2_m} \quad \ldots\ldots\ldots (2)$$

where:

P = indentation load in g,
d_m = measured (recovered) length of diagonals in μ, and
k = constant which depends on the form of the indenter.

The unrecovered hardness number H_u is, in analogy with this,

$$H_u = k \times \frac{P}{d_u^2} \quad \ldots\ldots\ldots (3)$$

where d_u = the unrecovered length of diagonals in $_u$. However,

$$d_u = d_m + \Delta l \quad \ldots\ldots\ldots (4)$$

and thus

$$H_u = k \times \frac{P}{(d_m + \Delta l)^2} \quad \ldots\ldots (5)$$

From Eqs 2 and 5 is now obtained

$$\frac{H_u}{H_m} = \frac{d_m^2}{(d_m + \Delta l)^2} \quad \ldots\ldots (6)$$

In Eq 6, H_m and d_m are obtained through direct measurements. By inserting values obtained with different indentation loads in micro-hardness tests, and through combination with equations systems having H_u and Δl as unknown, it will be possible to solve H_u and Δl. For reducing the influence of measuring errors as much as possible, an average value should be computed from the solutions of a number of equation systems according to the least square method.

The values of Δl obtained by Tarasov and Thibault varied between 2.5 and 6.5 μ. The H_u values (unrecovered hardness numbers), which could be calculated with the value of Δl known, proved to be independent of the load. This seems to prove the correctness of the line of thought along which Tate, Tarasov, and Thibault have worked, and is thus worthy of further study.

Some Further Studies of the Load Dependence of the Vickers Hardness Number and Calculation of H_u and Δl:

Tarasov's and Thibault's investigation concerned a Knoop indenter. Identical conditions, however, ought to exist for the Vickers diamond, although, owing to the shape of the Vickers diamond, smaller values of Δl should be expected. A less pronounced load dependence should therefore be found in testing with a Vickers diamond than with a Knoop diamond, which is also the case (**14**).

The conditions of Vickers testing have been studied in more detail on hardened steel, annealed 18–8 steel, and annealed iron. The results of these tests are reproduced in Figs. 8, 9, and 10.

The hardened specimen was polished electrolytically. The specimens of the two softer materials were first ground and polished in the cold-drawn state after which they were annealed in a vacuum and then polished electrolytically. Therefore the load dependence found is certainly not due to a cold-worked surface layer.

In all the tests the measured (that is, recovered) hardness numbers, H_m, indicated a pronounced load dependence.

The unrecovered hardness number, H_u, which was obtained through calculation, varies for the hardened steel (Fig. 8) within 20 Vickers numbers, that is, within approximately 2 per cent, in the load range 50 to 2000 g. The hardness number H_u can thus be regarded as independent of the load within this range. H_u for a 25-g load falls slightly outside the range, which can be explained through unavoidable errors of measurement on the short impression diagonals that result. The impression diagonal for this load is about 7 μ.

For the 18–8 steel (Fig. 9) and the soft iron (Fig. 10) a practically constant H_u value was obtained within the load range 25 to 2000 g and 50 to 2000 g, respectively.

The deviations in the H_u value at the lower loads are noticeable and cannot be explained by measurement errors alone. It can possibly be due, at least in part, to disturbances caused by the measuring being performed on a polycrystalline instead of a monocrystalline material. Other complications are also

[3] Brodie and Smoluchovski (**22**) coated the diamond with a thin layer of graphite.

conceivable, for instance formation of "piling up" and "sinking in" round the impressions.

Despite the deviations found at the lower loads the tests seem to have confirmed that the results obtained by Tate, Tarasov, and Thibault can be applied also to the Vickers testing.

Two questions which have been doubtful, namely, those relating to the cause of the load dependence and to the part played by the elastic recovery in Vickers testing, have thus been solved by the light thrown on these phenomena.

With knowledge of the Δl value for different structures it would furthermore be possible to obtain a hardness number which is independent of the indentation load—something that must be regarded as an advantage.

The elastic recovery in the Vickers test has also been determined experimentally by other methods. Bischof and Wenderott (7) have made very exhaustive investigations in which it was ascertained that the recovery was most pronounced in the direction of the depth but could also be detected in the direction of the diagonals. Tate (14), Brodie and Smoluchovski (22), have, through direct measuring on the indenter, also been able to detect that there is an elastic recovery in the direction of the diagonals.

Bernhardt (12), on the other hand, has not found any change in the length of the diagonals after unloading. As pointed out by Bischof and Wenderott (7) this result can be explained by complications caused by "piling-up" or "sinking-in" around the impressions.

Summary

In this paper some of the factors responsible for lack of agreement of results in micro-hardness testing have been more closely examined. Thus, the influence of indentation speed, the length of the contact period, shocks, vibrations, and the specimen preparation have been investigated.

A knowledge of the importance of these factors is essential in order to obtain correct test results.

A question of primary importance is the calibration of the measuring devices. One method of calibration, using a specially made optical grating (Siegbahn grating) has been described. It is of interest to observe that the calibration factor can vary over the range of measurements.

The main part of the paper is devoted to the load dependence of the hardness number, a question of major practical and theoretical importance. Load dependence has been observed for three materials investigated (hardened steel, soft annealed 18–8 stainless steel, and soft iron). Thus higher hardness numbers have been obtained at lower loads. In this case there is good agreement with most of the earlier investigations.

Use of Meyer's analysis in order to explain the load dependence as proposed by some authors has been proved to be erroneous.

Some calculations, based on the actual measurements, support an interpretation made by some American authors that the load dependence might arise from elastic recovery after unloading. The problem is, however, extremely complicated. Thus the amount of recovery seems to be larger in depth than along the diagonals. Furthermore the "piling up" and "sinking in" around the impressions make the interpretation more difficult.

It does not seem possible to evaluate the importance of the elastic recovery by means of depth measurements under load and after unloading. The regions around the actual impression are depressed elastically, and the extent of this seems impossible to measure.

Acknowledgments:

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A Laboratory Method of Test for No-Dirt-Retention Time of Traffic Paints[1]

A Progress Report by Subcommittee IV on Traffic Paints of ASTM Committee D-1 on Paints, Varnish, Lacquers, and Related Products

By F. S. Byerly,[2] F. H. Baumann,[3] H. H. Diefenderfer,[4] and G. W. Ashman[5]

SYNOPSIS

Cooperative tests were conducted in the Trenton laboratory of the New Jersey State Highway Department and the Palmerton laboratory of The New Jersey Zinc Co. (of Pa.) by one of the working groups of Subcommittee on Traffic Paints. The purpose of this work was to determine the feasibility of developing a method of test for the length of time necessary to dry freshly applied traffic-zone marking paint stripes to avoid dirt pickup or dirt retention from the tires.

The results obtained indicate that several hours' additional drying time may be required between the stage of no-paint-pickup by auto tires and the stage of no-dirt-pick-up from the tires. It appears that a convenient, simple, and easily reproducible method of test for determining the time required to reach the no-dirt-retention stage may be developed. The apparatus required in the proposed tentative method is that used in the ASTM Standard Method of Test for Dry to No-Pick-Up Time for Traffic Paint (D 711–48).[6] One dirt reagent that appears to be satisfactory for the test is sized road soil.

After fresh applications of road marking paints, it is common practice to barricade the area and thus prevent traffic from crossing the new lines during the drying period. The barriers are a nuisance and are frequently a traffic hazard, so every effort is made to remove them as quickly as possible. This removal is usually effected as soon as the fresh films have hardened to a stage that the tires will no longer pick up the paint. A standard method of test, ASTM Method D 711, has been found to be suitable for determining the "no-pick-up" time.

At the February, 1950, meeting of Subcommittee IV on Traffic Paints of Committee D-1, several members commented that freshly applied traffic lines were observed to become very dirty from tire marks, even though the films were dry to "no pick-up" prior to their exposure to traffic. It was further noted that these dirty marks disappeared after several weeks of service. Although the accumulation of dirt seemingly does not detract from the over-all durability of the traffic stripes, it is considered to give an unsightly appearance and to detract from the visibility and reflectance properties during the early stages of road service. It was suggested that method D 711 might be augmented with a test for "no-dirt-retention." This suggestion was approved and the problem was assigned to Group 5 of the subcommittee. This report summarizes the progress made by this working group.

EXPERIMENTAL

The Group 5 cooperative tests were made by: Mr. F. S. Byerly, U. S. Industrial Chemicals, Inc.; Mr. F. H. Baumann and Mr. H. H. Diefenderfer, New Jersey State Highway Department; Mr. G. W. Rundle and Mr. G. W. Ashman, The New Jersey Zinc Co. (of Pa.). The work was carried out at the Trenton Laboratory of the New Jersey State Highway Department and at the Palmerton Laboratory of The New Jersey Zinc Co. (of Pa.). At the former, Messrs. Byerly, Baumann, and Diefenderfer tested three white traffic paints supplied by U. S. Industrial Chemicals, Inc., and two white traffic paints supplied by the New Jersey State Highway Dept. At the latter, seven white and three yellow traffic paints prepared by the Palmerton Laboratory were tested. The three paints supplied by U. S. Industrial Chemicals, Inc., were based on the formula in the ASTM method D 969,[7] and the two paints supplied by the Trenton Laboratory conform to the New Jersey State Highway Dept. specifications for traffic paints. These studies, however, were not concerned with formulation, but with differences between the "no-pick-up" time and the "no-dirt-retention" time.

The preliminary phase of the laboratory work considered various dry, powdered reagents for dirtying the fresh film of traffic paint after it had dried to the "no-pick-up" stage as determined by the Standard Method D 711. Colored pigments, lampblack, powdered slate, refractory cement, and ordinary road soil were tried in the two laboratories. It was found that a very large ratio of extremely fine size particles in the pigments did not make for a sharp end point. On the other hand, a predominance of relatively coarse particles in the reagent tended to indicate a prematurely early end point. The road soil was finally selected as the dirt reagent for use in the tests. To assure a standard maximum particle size, this was screened through the 297 μ size sieve (U. S. Standard No. 50 sieve).[8]

TEST PROCEDURE

The traffic paint films were cast on plate-glass panels with a drawdown applicator of 0.02 in. clearance. In the Trenton tests, the paints were dried in the laboratory at room temperature. In the Palmerton tests, the paints were applied and dried in a constant-temperature room at 77 F. and 65 per cent relative humidity, with all paints and panels being allowed to reach temperature equilibrium in the constant-temperature room before application. The dry to "no-pick-up" times were determined for each film by the D 711

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[1] This progress report is being published to encourage trial runs of similar tests by users of road-marking paints. Reports on the results obtained or on effective modifications of the procedure will be welcomed and should be addressed to Dr. W. G. Vannoy, Chairman, Subcommittee IV, Pigments Department, E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.

[2] Manager, Resin Technical Sales Dept., U. S. Industrial Chemicals, Inc., New York, N. Y.

[3] Chief, Testing Division, New Jersey State Highway Dept., Trenton, N. J.

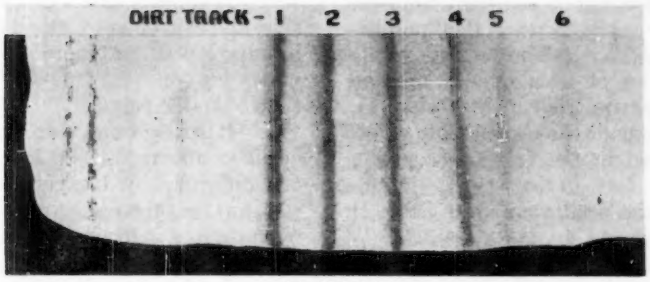
[4] Chemist, New Jersey State Highway Dept., Trenton, N. J.

[5] Investigator, New Jersey Zinc Co. (of Pa.), Palmerton, Pa.

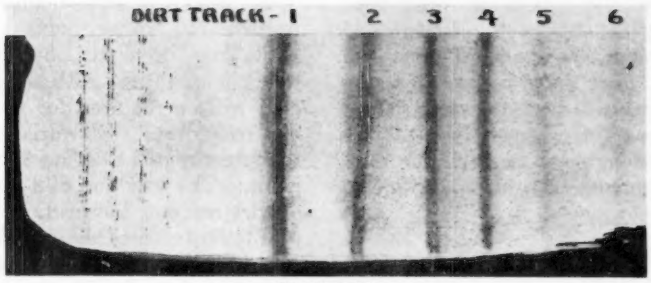
[6] 1949 Book of ASTM Standards, Part 4, p. 388.

[7] Tentative Method of Laboratory Test for Degree of Resistance of Traffic Paint to Bleeding (D 969–48 T), 1949 Book of ASTM Standards, Part 4, p. 382.

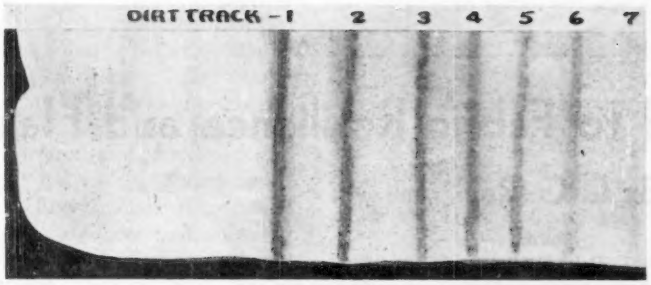
[8] Standard Specifications for Sieves for Testing Purposes (E 11–39), 1949 Book of ASTM Standards, Part 4, p. 1165.



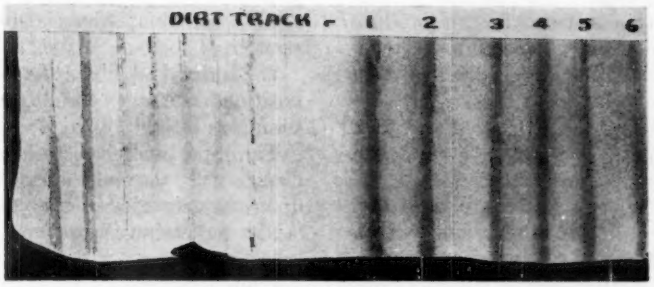
(*a*) 45-P-59.



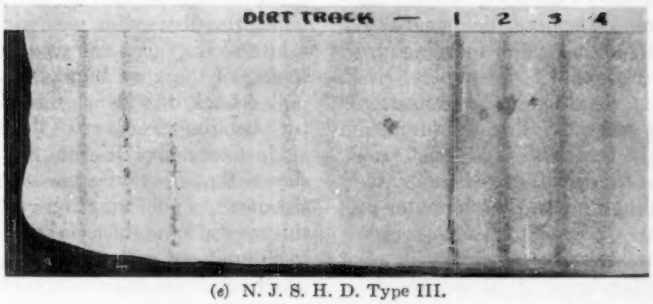
(*b*) 45-P-60.



(*c*) 45-P-61.



(*d*) N. J. S. H. D. Type I.



(*e*) N. J. S. H. D. Type III.

Fig. 1.—Laboratory Dry-to-No-Dirt-Retention Test as shown in Table III.

method. These results are listed in Tables I and II for the Trenton Laboratory tests and in Table III for the Palmerton Laboratory tests.

After the paints had reached the "no-pick-up" stage, the road soil reagent was sprinkled across each test stripe in a narrow band. The rubber-tired, weighted wheel used in the D 711 method was then rolled across the dirt streak to assure pressure on the fresh film that would simulate that experienced on the highway. A dry paint brush was then used to brush away the dirt. This procedure was repeated periodically until none of the road soil reagent remained embedded in the paint, a condition considered to be the end point for the test. It should be pointed out that even at this stage the

TABLE I.—LABORATORY DRY TO NO-DIRT-RETENTION TESTS.

Paint	Time to Dry-to-No-Pick-Up[a]	Time to No-Dirt-Retention
N.J.S.H.D. Traffic paint Type I Med. Soya Gl. Ph. Alkyd in V. M. & P.....	37 min	More than 5 hr
45-P-59 Med. Soya Gl. Ph. Alkyd in V. M. & P.....	36 min	More than 5 hr
45-P-60 Med. Soya Gl. Ph. Alkyd in M. S..	1 hr 7 min	More than 5 hr
45-P-61 Med. Soya Pe. Ph. Alkyd in M. S..	56 min	More than 5 hr

[a] Laboratory temperature 75 F. (outside temperature 68 F.). Relative humidity (inside) 58.

TABLE II.—LABORATORY DRY TO NO-DIRT-RETENTION TESTS. See Fig. 1

Paint	Time to Dry to No-Pick-Up[a]	Time to No-Dirt-Retention
45-P-59 Med. Soya Gl. Ph. Alkyd in V. M. & P.....	45 min	5 hr
45-P-60 Med. Soya Gl. Ph. Alkyd in M. S..	1 hr 18 min	7 hr
45-P-61 Med. Soya Pe. Ph. Alkyd in M. S..	1 hr 5 min	7 hr
N.J.S.H.D. Type I Med. Soya Gl. Ph. Alkyd in V. M. & P.....	1 hr 9 min	More than 8 hr
N.J.S.H.D. Type III[b] Toluol Solution of Varnish and Chlorinated Rubber.....	12 min	37 min

[a] Laboratory temperature 73 F. (outside temperature 50 F.). Relative humidity (inside) 42.

[b] For crosswalks—vehicle: 4 parts of 25 gal tung oil - penta ester varnish, 1 part chlorinated rubber. Solvent is toluol. Benzene is the paint thinner.

TABLE III.—LABORATORY DRY TO NO DIRT-RETENTION TESTS.

	Time to Dry to No-Pick-Up	Time to No-Dirt-Retention
June 5, 1950, Series		
1-W (White)[a]	35 min	4 hr 13 min
2-W (White)[b]	24 min	3 hr 40 min
3-W (White)[b]	12 min	3 hr 38 min
1-Y (Yellow)[a]	31 min	5 hr 35 min
2-Y (Yellow)[b]	30 min	4 hr 2 min
3-Y (Yellow)[b]	19 min	4 hr 0 min
June 22, 1950, Series		
A (White)[c]	2 hr 5 min	5 hr 5 min
B (White)[c]	2 hr 48 min	5 hr 10 min
A-1 (White)[a]	1 hr 31 min	5 hr 0 min
B-2 (White)[a]	1 hr 44 min	4 hr 59 min

[a] Mineral spirits in the alkyd resin solution V. M. & P. naphtha used as the paint thinner.
[b] V. M. & P. naphtha in the alkyd resin solution and as the paint thinner.
[c] Mineral spirits in the alkyd resin solution and as the paint thinner.

finer particles of the dirt reagent caused a slight staining on the paint stripe, but it is considered that this will occur regardless of the age of the film because of the semiporous and roughened texture of traffic paint films. The "no-dirt-retention" times noted are listed in Tables I, II, and III.

The results shown in Table I represent the first trial, and it will be noted that $5\frac{1}{4}$ hr was not sufficient time for any of the paints to reach the "no-dirt-retention" stage. The results of a second series of tests at the Trenton Laboratory are shown in Table II. These tests used the same paints which were applied in the first series plus a cross-walk fast drying type. Photographs of the results noted in Table II are shown in Fig. 1.

There is a slight disagreement on the 45-P-59 paint in the two series of tests, since this film reached the "no-dirt-retention" stage after 5 hr in the second series of tests, but failed to reach this stage after $5\frac{1}{4}$ hr in the first tests. This may have been due to differences in humidity during the two series of tests. Further work will be required to determine the margin of error that will result from differences in drying conditions, the personal factor with different operators, etc.

Results Indicated

The results of these cooperative tests do not justify definite conclusions but they do indicate the following:

1. It appears that a simple, inexpensive, and convenient method of test may be developed for reproducible determinations of the "no-dirt-retention" time of traffic paints.
2. It appears that the test procedure outlined above may be followed without difficulty by inexperienced operators, but that the results may be affected by variations in drying conditions, types of reagents, etc.
3. Sized road soil appears to be a practical dirt reagent for use in this method.
4. Probably some definition of the particle size range, moisture content limitations, general physical properties, color contrast with the paint film, etc., will be required for the standard dirt reagent, as such variations appear to influence the sharpness of the end point. The selection of a specific type of dirt reagent, however, does not appear to be a critical phase of the method.
5. With the types of traffic paints tested, and under the procedure followed, the "no-dirt-retention" time was found to be decidedly longer than the "no-pick-up" time.

Fiber Properties Related to Fabric Resilience and Hand*

By L. G. Ray[1]

Although differences in the resilience and hand of fabrics are easily observed subjectively, these interrelated qualities are in reality very complex. They probably depend on the physical properties of the fibers in the fabric (**3, 4, 6, 7, 8, 9, 13**)[2] and the geometry of the fibers, yarns, and fabrics (**1, 5, 11, 12, 14, 15**). There have been many attempts to determine quantitatively how much and in which direction changes in these parameters affect fabric behavior. Much progress has been made, but thus far it has not been possible to set up formulas which will allow the behavior of a fabric to be calculated in detail from values for physical constants of the fibers and from form factors describing the fabrics geometry.

Producers of synthetic fibers are naturally most interested in how resilience and hand of fabrics are related to fiber properties because methods for control and modification of such properties are well known to them. New polymers can be synthesized, and existing fibers can be greatly modified if desired. Moreover, experience indicates that while faulty construction can produce poor fabrics from good fibers, no technique is available for producing really good fabrics from poor fibers.

Hand and Resilience

This paper is concerned only with the relation of fiber properties to hand and resilience. In the discussions which follow, fiber cross-section shapes, yarn construction, and fabric constructions will be considered identical for the materials studied.

Deformations of clothing fabrics are almost always bending deformations. Creasing, wrinkling, and mussing are all manifestations of incomplete recovery from bending. The sensation experienced when a fabric is crumpled or crushed in the hand is at least partially due to the resistance of the material to bending and to the character of its recovery.

If—as we strongly suspect—the recovery and the hand of fabrics are determined in a large measure by fiber properties, which of such properties are most important? It will be helpful to analyze how fibers in fabrics comply when the fabric is bent. Two distinct mechanisms may operate either singly or together:

1. Individual fibers may bend or stretch.
2. Individual fibers may shift their positions in the yarns either by longitudinal or lateral slippage.

The importance of each of these mechanisms will depend to some extent upon the geometry of the yarn and the fabric, but it can be assumed that both take place.

If longitudinal slippage of fibers occurs to any large extent, it is difficult to understand how yarns can recover from deformation. If, on the other hand, the fibers slide past each other in a lateral displacement resulting in flattening of the yarn bundle, they can be pulled back into their original positions by bending recovery forces acting against interfiber friction. It has been shown that fibers are anisotropic in resistance to deformation (**13**). Since this may also be the case with resistance to sliding past each other, it is probably worth while to determine coefficients of interfiber friction, both parallel and perpendicular to the fiber axes.

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* Presented before a meeting of Subcommittee B-1 on Test Methods of ASTM Committee D-13 on Textile Materials in New York City, March 15, 1951.

[1] E. I. du Pont de Nemours and Co., Inc., Rayon Dept., Technical Div., Wilmington, Del.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

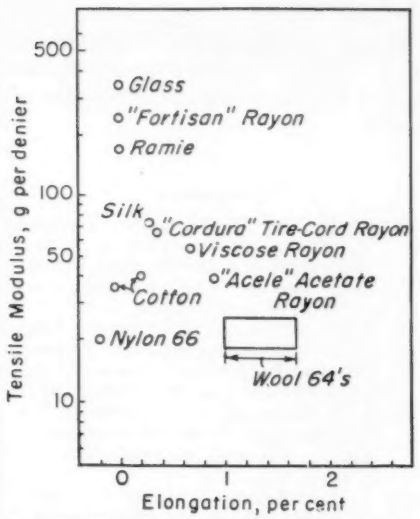

Fig. 1.—Modulus Values for Several Textile Fibers.

If the fibers in the fabric respond by bending only, the resilience and hand should be determined by the resistance of the fiber to bending and its subsequent recovery. Since the bending properties of single fibers are difficult to measure, it has been common practice to assume that bending behavior can be adequately described by the results of tests in tension. This assumes bending to be a pure tensiie strain and is correct only if the cross-section shape of the filaments does not change during bending. Fiber stiffness can be determined from stress-strain curves and recovery can be measured directly by observing how much a fiber recovers from a given strain.

Two questions now arise: (1) What time scale should be considered for testing? (2) What range of deformation is important? The first question has been generally answered on the basis of convenience and practicality of testing, but fiber properties have been measured over a time range from sonic frequencies (**2**) to days, weeks, and months (**10**). Most of the data reported here were measured in tests of several minutes duration. The second question is susceptible to rough calculations, which indicate that maximum fiber deformations in sharply creased fabrics may amount to about 10 per cent elongation. Most deformations are probably much less than this.

Fiber properties important to fabric behavior should then lie in the range of 0 to 10 per cent fiber elongation. Over this range, many stress-strain curves are nonlinear, although almost all of them have a linear region for some distance away from zero elongation. The elastic modulus can be calculated from this linear region and is therefore expected to be a significant property relating to the hand of fabrics. For fibers having cross-sections of the same shape and area, the higher the modulus, the stiffer will be a given fabric structure made from the fiber.

In Fig. 1, taken from the work of Beste and Hoffman (**3**), are given a number of modulus values for several textile fibers.

The picture presented by these data is generally in accord with the results of subjective tests. If, however, single fibers can be subjected to tensile strains of the order of 10 per cent, then regions of the stress-strain curve well beyond the early linear portion must be of interest in describing hand. What is needed is a numerical description of the shape of stress-strain curves after the early straight line portion. Beste and Hoffman (**3**) have suggested the *compliance ratio* as a means of doing this. The compliance ratio is simply the average

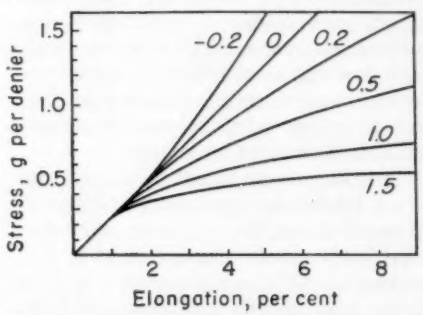

Fig. 2.—Synthetic Stress-Strain Curves. The number on Each Curve Indicates the Rate of Change of Compliance with Elongation.

rate of change of compliance between two different elongations (Beste and Hoffman used 5 and 10 per cent).

$$\text{Compliance} = \frac{\text{strain}}{\text{stress}}$$

$$\text{Compliance ratio} = \frac{\text{compliance at 10 per cent elongation} - \text{compliance at 5 per cent elongation}}{}$$

To illustrate its use, Fig. 2, also taken from Beste and Hoffman's paper, presents several synthetic stress-strain curves characterized by compliance ratios from −0.2 to 1.5.

What do these mean in terms of fabric hand? For two fibers with a given initial modulus, the one having a negative compliance ratio stiffens up as strain becomes greater while that having a compliance ratio greater than 0 becomes more compliant. One is stiff and the other is crisp but soft. Nylon 66 has a compliance ratio of approximately −0.15 and wool one of about 1.5.

So far, the recovery properties of fibers have not been discussed. These also must be involved in hand as well as in recovery from creasing and wrinkling. Both elastic recovery and work recovery, measured from any elongation up to 5 per cent or higher, can be related to fabric crease recovery. To

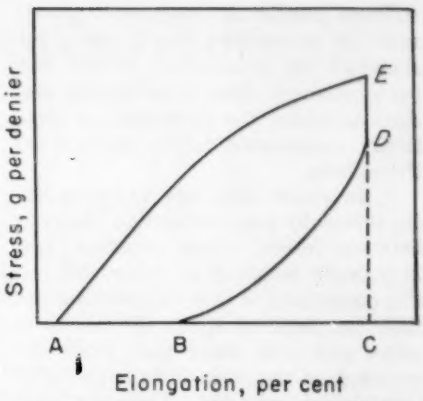

Fig. 3.—Recovery Properties of Fibers. A Cycle of Extension and Recovery.

determine either of these quantities, a cycle of extension and recovery is run on a fiber and the results plotted in the form shown in Fig. 3.

Distance *BC* divided by *AC* and multiplied by 100 is the per cent elastic recovery, and the area under curve *BDC* divided by the area under *AEC* and multiplied by 100 is the per cent work recovery. It appears logical that work recovery should be a more significant parameter of fabric recovery than elastic recovery, since it is doubtful that recovery under no load can occur in fabrics. Certainly, if our hypothesis of lateral rearrangement of filaments in a bent yarn is correct, enough recovery energy must be available to move these filaments back to their original positions. The fibers with higher work recovery store up more energy in the fabric and the more stored energy, the more complete should be recovery. A plot of fabric crease recovery *versus* work recovery for a number of different types of fibers is given in Fig. 4, which is also taken from the paper of Beste and Hoffman (**3**). With one exception (nylon 66), the correlation is quite good.

It appears, therefore, that for most fibers, measurements in tension of initial

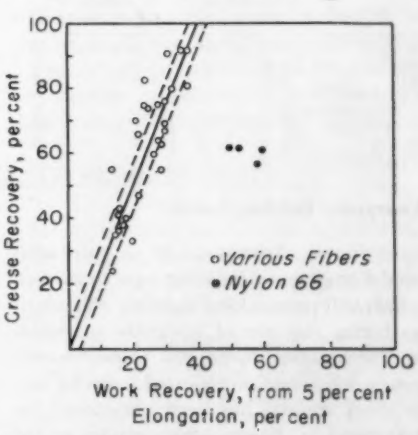

Fig. 4.—Fabric Crease Recovery *versus* Fiber Work Recovery from 5 per cent Elongation.

stiffness (elastic modulus), compliance ratio (or some other description of the shape of the stress-strain curve), and work recovery allow quantitative predictions about the properties of identically constructed fabrics made from these fibers.

Is there now some way to rationalize the unusually poor correlation observed between fabric crease recovery and fiber work recovery of nylon 66? In this connection, it is worth pointing out that the hand of nylon 66 fabrics is softer and more waxy than would be expected on the basis of its respectably high initial modulus. This fact also needs explaining. It was pointed out earlier that tensile measurements can be used to describe bending behavior only if no change in fiber cross-section shape occurs during bending. Any shape change involves a shearing deformation. This is likely to occur when the resistance of a fiber to shearing stress is less than its resistance to tensile stress. The fiber will obviously deform by the easiest path available to it. Two quantities are important in this connection:

1. The relative resistance of the material to deformation by tensile stress and by shearing stress, and
2. The actual magnitude of the resistance to shear (shear or torsional modulus).

The latter can be simply measured by a torsion pendulum technique, and the former can be estimated by dividing the elastic modulus in tension by the torsional or shear modulus both in the same units. This ratio has been called the anisotropy factor (**13**). For an isotropic material, the ratio of the moduli will equal 3. If the ratio is greater than 3, the material is more easily deformed in shear than in tension, and if less than 3, the material is more easily deformed in tension than in shear. Table I, from a previous paper (**13**) by this author, presents such data on several textile fibers. The figures do, in fact, show that nylon should shear or change shape more readily than it elongates. It is also significant that such small forces resist shear, since this means that equally small or smaller forces will be available to bring about a recovery against restraints such as might need to be overcome if fibers have shifted positions laterally during bending and need now to return to their original positions.

TABLE I.—COMPARISON OF RIGIDITY AND YOUNG'S MODULI FOR TEXTILE FIBERS.

Fiber	G, dynes per sq cm	E, dynes per sq cm	E/G
Wool	1.7×10^{10}	3.4×10^{10}	2.0
Casein	1.3	2.9	2.2
Silk	1.2	13.9	11.5
Cellulose			
Unstretched	1.4	5.0	3.5
Stretched	1.6	17.1	10.5
Nylon	0.4	2.4	6.0
Polyethylene	0.3	...	...

If, on the basis of these considerations, we assume that nylon 66 fibers shear out of shape when bent, we have an explanation for both the waxy feel of such fabrics and their unexpectedly low crease recovery. They can be deformed much more readily than would be imagined from their initial tensile moduli, and they can exert relatively little force to overcome restraints imposed on their recovery by frictional resistance or other factors as yet undefined.

It is important to note that polyethylene fabrics have properties similar to those of nylon 66, and that polyethylene fibers are also characterized by low resistance to shear associated with a fairly high tensile modulus and high work recovery from tensile strains.

Summary

The hand and resilience of fabrics can be related to five fundamental fiber properties:

1. Elastic modulus in tension.
2. Shape of the stress-strain curve.
3. Ability to recover the work of elongation.
4. Shear modulus.
5. Degree of anisotropy.

The influence of these fundamental properties can be modified by geometrical factors such as fiber cross-sectional shape and area, yarn construction, and fabric construction. Interfiber friction may also have important effects. It is suggested that interfiber friction should be measured perpendicular to the fiber axes as well as parallel to them.

Acknowledgment:

I wish to thank R. M. Hoffman and L. F. Beste for allowing the use of several of their illustrations in this presentation.

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Emergency Building Codes

Approval of a proposed model emergency building code ordinance which will permit local building officials to authorize the use of alternate materials and techniques during the present emergency, when certain required materials are in short supply, has been announced by Raymond M. Foley, Administrator of the Housing and Home Finance Agency.

The formal title of the ordinance is: "An Emergency Ordinance Amending All Building, Electrical, Gas, Mechanical, Plumbing, and Related Ordinances; Authorizing the Use of Alternate or Substitute Materials and Methods during the Period of National Emergency."

The document consists of three parts: (1) the introduction, which explains the necessity for such an ordinance; (2) the ordinance itself; and (3) explanatory notes on the ordinance to point up its principles and the purpose of its provisions, and indicate which provisions need local modification to fit local needs.

The introduction points out that the ordinance has been prepared as a guide and suggestion for action to city councils, mayors, city managers, and building officials of cities whose building codes do not permit authorization of alternate materials and methods in times of emergency. Cities wishing to take such action would have to adapt the ordinance to fit the relevant portions of state laws, municipal charters, and local building codes.

The Measurement of Stiffness in Textile Fabrics*

By N. J. Abbott[1]

SYNOPSIS

The subjective evaluation of stiffness is used as a standard with which to compare the results obtained from five laboratory methods of measuring stiffness. Measurements were made on a range of 19 fabrics of varying fiber content, weave, and weight. The results indicated significant correlation in the case of four of the five methods. The test was repeated with a new range of eleven fabrics, with approximately the same results. The Peirce Cantilever Test was selected as being the most convenient to carry out in the laboratory, and at the same time giving good correlation with the subjective estimate. There is described a more detailed examination of certain aspects of the Cantilever Test, and a specific technique is recommended which combines simplicity of equipment with ease of measurement.

A COMPARISON OF FIVE METHODS OF LABORATORY EVALUATION

STIFFNESS is one of the characteristics of a fabric that goes into making up that important quality known as "hand." Other physical properties which have been suggested as contributing to the hand of a fabric are compressibility, extensibility, resilience, density, surface contour, surface friction, and thermal character (1).[2] All of these properties may not be equally important, and others, such as thickness, for example, may contribute substantially to the sensation one gets when feeling a fabric. An attempt to evaluate the hand of a fabric in the laboratory is made difficult by the fact that no specific definition of hand exists, nor, indeed, does a specific definition of many of its components, such as stiffness, compressibility, resilience, etc. This, then, is the problem encountered in any attempt to measure any of these properties in such a way that the results mean something to the man who is accustomed to handling fabric, and who uses these terms presumably to signify some specific subjective reaction upon feeling the fabric.

When a person accustomed to handling textiles feels a fabric, he is able to form a definite opinion as to whether he considers it stiff or soft. It might be possible, then, to use this subjective evaluation as a reference standard of stiffness, with which to compare the evaluation resulting from a laboratory test. This could only be done, however, provided the subjective estimate is a sensitive one, that is, it can distinguish between two fabrics of nearly the same stiffness, and provided a number of such evaluations, made by different people, can agree. Clearly this is a case simply of ranking fabrics in a given order, without regard to the absolute value of the difference between them. Therefore if a group of persons can rank a range of fabrics in essentially the same order, and any given laboratory test ranks them in the same order, this may be considered to be evidence of the fact that a definite relationship exists between what the test measures and what is commonly known as stiffness. Moreover, if the test gives a quantitative measure, a scale of stiffness has been established so that absolute differences may be obtained.

In the present investigation a number of fabrics were selected to cover a fairly broad range of stiffness, without regard to fiber content or construction. These were ranked subjectively by a group of people, and then subjected to laboratory evaluation by five methods which have been proposed for measuring stiffness. The methods used include the Cantilever and Heart Loop Tests proposed by Peirce (7), Schiefer's Flexometer (8), Dreby's Planoflex (5, 6), and the Massachusetts Institute of Technology Drapeometer (10).

The fabrics were ranked in order according to the results of each test, and each of these rankings compared to the reference standard obtained from subjective evaluation, by using Kendall's coefficient of rank correlation (9, 11). All methods except the MIT Drapeometer gave significant correlation coefficients, the flexural rigidity obtained from the Cantilever test being the best.

A repetition of the whole test using another range of eleven fabrics gave substantially the same results. Thus, on the basis of correlation alone, the Cantilever test would be selected as the most suitable. However, this cannot be the sole criterion. Simplicity of apparatus required and the ease with which the test may be carried out are important considerations. On these grounds one would also select the Cantilever test. Therefore it would seem to be the test most worthy of serious consideration as a standard laboratory test for stiffness. A further investigation into the use of this test is described below.

PEIRCE CANTILEVER TEST FOR STIFFNESS OF TEXTILE FABRICS

The Cantilever test, as described by Peirce (7), has been shown to give results that correlate well with a subjective rating of stiffness, which has been adopted as a reference standard. However, the best technique to be used for carrying out the test is not definitely established. Winn and Schwarz (10) have shown that the value obtained for bending length, as measured by the heart loop, is dependent upon the length of the fabric strip tested. No such information is available giving the effect of length of overhang in the Cantilever Test upon the value for the bending length obtained. There is little information about the best basis of comparison for different types of fabric, whether the measurements should be made on the basis of constant length of overhang, or perhaps constant angle of bend. Peirce (7) states, "The length

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* This is a condensation of a paper presented by the author on March 15, 1951, before the meeting of Subcommittee B-1 on Test Methods of ASTM Committee D-13 on Textile Materials in New York City. The text appears in full in the *Textile Research Journal*, Vol. 21, p. 431, June, 1951.

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[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

of overhang should be chosen to give a deflection of 20 to 30 deg, or more for flimsy materials, since very short lengths also mean increased errors of observation." Also in the description of the test method in "Methods of Test for Textiles," published by the British Standards Institution (3) it is suggested that a length of overhang be used which gives an angle of 20 to 40 deg. No reason is given for such a statement, and no experimental evidence to support it. Therefore it was felt that a measure of bending length for different lengths of overhang for a range of fabrics would be valuable.

Fabrics Used

The range of fabrics used is described in Table I. They were chosen to represent a variety of fibers and weaves, as well as a rather wide range of stiffness.

TABLE I.—DESCRIPTION OF FABRICS USED.

Code Letter	Fabric	Weight, oz per sq yd
A″...	Nylon sateen	2.2
B″...	Viscose rayon plain weave	2.8
C″...	Viscose rayon crepe	3.2
D″...	Nylon plain weave (sportswear fabric)	3.5
E″...	Nylon twill (tarpaulin fabric)	3.9
F″...	Spun viscose plain weave	4.5
G″...	Cotton poplin (sportswear fabric)	6.1
H″...	Nylon oxford weave (sportswear fabric)	6.1
I″....	Acetate rayon satin (sportswear fabric)	7.7
J″...	Worsted men's suiting	8.5
K″...	Wool overcoating	14.0

Method of Measurement

Measurements were made at 65 per cent relative humidity, 70 F, on an instrument such as is described by Peirce (7), using a strip of fabric 1 in. wide by 6 in. long. Four strips were cut with the long dimension parallel to the warp, and four with the long dimension parallel to the weft. Four readings were taken on each fabric sample, one at each end with the face up, and the same with the back up. Thus 16 readings were obtained for warpwise bending and 16 for weftwise bending. An arithmetic mean of each set of 16 readings was taken, and a geometric mean of the warp and weft values to obtain one figure representative of the fabric as a whole. A similar set of readings was made for at least four lengths of overhang for each fabric, using the same set of samples each time, thus reducing differences due to sampling to a minimum. These figures are given in Table II.

The calculation of the bending length from the observations can be made in several ways. Peirce (7) has described one method, and Bickley (2) has described several others, based upon a more rigorous solution of the differential equations involved. In order to compare these methods, the bending length was calculated in four ways:

(*a*) a graph of c/l against θ,
(*b*) a graph of $l^3/c^3 \tan\theta$ against θ,
(*c*) a table, with first and second differences, giving l^3/c^3 in terms of $\tan\theta$, and
(*d*) the relationship $c = l\left(\frac{\cos 0.5\,\theta}{8 \tan\theta}\right)^{1/3}$.

where:

c = bending length,
l = length of overhang, and
θ = angle of dip.

The first three methods are suggested by Bickley, the fourth by Peirce.

Method (*c*) is considered by Bickley to be the most reliable of these methods of computing bending length, then (*b*), (*a*), and (*d*) in that order. Method (*d*), which is Peirce's, gives consistently high results except at the low angles. In the middle range of angles (30 to 50 deg) there is little difference between (*a*), (*b*), and (*c*) Bickley's methods. However, at low and high angles differences may show up due to the fact that in many cases the available graphs had to be extrapolated. which inevitably introduces error. It would appear, therefore, that it would be safe to accept method (*a*) as a simple, reliable method of computation. Figure 1 shows the results computed by method (*a*) for the bending length of some of these fabrics plotted against the angle of dip. It is unnecessary to confuse the graph by plotting the remainder of the results, for they are all essentially the same shape, that is, slightly concave upwards. In most cases the variation in bending length is not great. However, if one were to pick a most satisfactory range of angles over which the measurement should be made, the range 40 to 50 deg would seem to be the best since in this range the bending length is most nearly constant for all the fabrics tested. In making the recommendation of 20 to 30 deg as a suitable range, Peirce may have had in mind that this method of computation is more accurate up to 30 deg than it is at higher angles. However, it seems clear that in some cases the

TABLE II.—BENDING LENGTH AT DIFFERENT LENGTHS OF OVERHANG.

Fabric	Length of Overhang, cm	Mean Angle of Dip, deg	Mean Bending Length, cm			
			Method *a*	Method *b*	Method *c*	Method *d*
A″...	2	10.1	1.81	1.79	1.79	1.78
	3	30.9	1.74	1.74	1.74	1.76
	4	52.5	1.70	1.72	....	1.76
	5	64.6	1.82	1.76	....	1.84
B″...	2	10.7	1.75	1.73	1.73	1.71
	3	31.6	1.72	1.73	1.77	1.76
	4	52.4	1.71	1.71	....	1.77
	5	62.4	2.02	1.82	....	1.90
C″...	2	10.9	1.71	1.73	1.73	1.73
	3	36.8	1.59	1.60	1.60	1.62
	4	57.2	1.59	1.59	....	1.65
	5	68.1	1.75	1.63	....	1.75
D″...	3	7.4	....	3.21	3.21	3.22
	4	21.0	2.80	2.85	2.85	2.89
	5	39.8	2.57	2.59	....	2.63
	6	52.6	2.60	2.58	....	2.65
E″...	4	8.4	3.89	3.90	3.89	3.90
	5	15.8	3.80	3.86	3.86	3.86
	6	27.0	3.75	3.74	3.74	3.77
	7	38.0	3.65	3.69	3.70	3.74
	8	46.9	3.68	3.70	....	3.80
F″...	2	8.2	1.95	1.95	1.95	1.95
	3	26.1	1.87	1.89	1.89	1.91
	4	47.0	1.84	1.85	....	1.90
	5	60.3	1.92	1.89	....	1.97
G″...	4	13.4	3.22	3.30	3.29	3.29
	5	30.4	2.95	2.97	2.95	3.00
	6	46.0	2.88	2.82	....	2.88
	7	59.9	2.70	2.65	....	2.78
H″...	3	6.3	3.14	3.15	3.15	3.15
	4	18.5	2.85	2.86	2.87	2.87
	5	34.6	2.73	2.75	2.76	2.78
	6	47.0	2.75	2.78	....	2.84
	7	58.4	2.76	2.75	....	2.85
I″...	4	8.2	3.80	3.95	3.95	3.82
	5	16.3	3.70	3.76	3.76	3.76
	6	31.2	3.45	3.49	3.48	3.51
	7	44.0	3.40	3.38	....	3.41
	8	54.7	3.30	3.34	....	3.42
J″...	3	16.3	2.26	2.28	2.30	2.30
	4	34.5	2.20	2.21	2.22	2.24
	5	49.7	2.21	2.15	....	2.24
	6	61.1	2.28	2.22	....	2.34
K″...	3	7.3	3.05	3.07	3.07	3.07
	4	22.0	2.67	2.70	2.72	2.72
	5	37.5	2.62	2.64	2.65	2.68
	6	51.6	2.59	2.57	....	2.68
	7	62.3	2.63	2.56	....	2.68

slope of the bending length *versus* angle curve is rather too great in the region 20 to 30 deg to make it a satisfactory range.

Having established this fact, consideration should be given to the method used by Chu, Cummings, and Teixeira (4), in which the overhang corresponding to a given angle is measured, rather than the angle corresponding to a given overhang. It is obviously not feasible to select a standard length of overhang for all fabrics, but a standard angle could be chosen, provided it is in the range 40 to 50 deg. This happens to be a convenient range, for it is here that c/l is about 0.5. Chu, *et al.*, took $c/l = 0.500$ at 43 deg, which is obtained from Peirce's data. Using Bickley's more accurate data, it is found that $c/l = 0.500$ at 41 deg. That is, for an angle of dip of 41 deg the bending length is one half the length of overhang.

The adoption of such a method of measurement simplifies the calculation, and also the equipment required, for all that is needed is a horizontal platform, an indicator inclined at an angle of 41 deg below the horizontal, and a means of measuring length of overhang. A satisfactory device has been found to be a steel rule carrying a centimeter scale, with a thin sheet of rubber cemented to the back. The rule is laid on top of the fabric strip with its zero opposite the end of the fabric, and the pair slid together slowly but steadily off the edge of the platform until the angle of dip is 41 deg. The reading on the rule, opposite the edge of the platform, gives the length of overhang directly. The rubber backing on the rule prevents any slippage between the rule and the fabric. It is also advisable to place a weight on top of the rule and the fabric in such a way that they are held flat against the horizontal platform right to its edge.

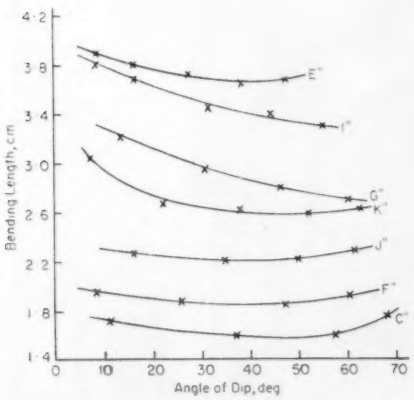

Fig. 1.—The Variation of Bending Length with Angle of Dip.

Measurements of bending length of all these fabrics were also made in this way. Results are given below, and for comparison the values obtained previously at the same angle (41 deg), as read from a plot such as Fig. 1, are also given.

Fabric	Mean Bending Length		Ratio
	Constant Angle 41 deg	Previous Value	
A".....	1.58	1.72	0.93
B".....	1.54	1.71	0.91
C".....	1.40	1.58	0.88
D".....	2.24	2.56	0.86
E".....	3.39	3.66	0.93
F".....	1.67	1.84	0.91
G".....	2.37	2.84	0.84
H".....	2.48	2.74	0.91
I".....	3.03	3.39	0.90
J".....	1.98	2.19	0.90
K".....	2.17	2.58	0.83

The fact that the value obtained by this method is somewhat lower than that obtained by the previous method could hardly have been anticipated by intuitive reasoning. However since in the constant angle method the bending moment is continually increasing up to the final observation, while in the constant length of overhang method it is continually decreasing, one would hardly expect to get the same result in the two methods. Nevertheless there is no reason to feel that one is a less reliable method than the other. Moreover since the ratio of the results obtained by the two methods is sensibly constant, both will rank fabrics in essentially the same order. Since this is a comparative scale only, it would seem immaterial which method is used, provided all measurements are done the same way. In view of this fact, the constant angle method is recommended as the simplest both from a standpoint of equipment required and technique.

Summary

A technique has been developed for the measurement of stiffness in textile fabrics using the cantilever method as suggested by Peirce. It is proposed that the best basis for comparison of fabrics is measurements made at a standard angle of dip, 41 deg, at which angle the bending length is one half the length of overhang. It was shown in the first section of the paper that the best measure of stiffness is the flexural rigidity of the fabric, which is its weight per unit area multiplied by the cube of its bending length.

Acknowledgments:

The author acknowledges with pleasure the assistance of all those who participated in this work, which has been carried out intermittently over the past seven years, either by making the measurements in the laboratory, or by helping to establish the subjective ranking. He is particularly grateful for the advice and criticism offered by Mr. A. C. Goodings, and Mr. Lyman Fourt, who is chairman of a task group on the measurement of hand in ASTM Committee D-13 on Textile Materials. The work described was done under the sponsorship of Canadian Industries Limited, Nylon Division, with whose permission it has been published.

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An Improved Electronic Flexometer for Bending Analysis and Stiffness Studies of Fabrics and Thin Plastics

By H. H. Hebeler,[1] H. J. Kolb,[1] J. W. Stillman,[2] and J. H. Baldt[2]

Over the past few years, a number of tests have been devised for measuring the bending properties of fibers, fabrics, and film (2, 3, 4). However, these previous investigations did not uncover an instrument which would possess all the features which were considered mandatory for the measurement of bending properties by our laboratory. These features are listed below.

1. Automatic recording of load as a function of time in order to evaluate rates as a function of time.
2. Extreme sensitivity with the minimum of moving parts in order to measure small bending forces in light fabrics and limp films.
3. Measurement of recoveries from flexure as well as flexural moduli in order to indicate intrinsic properties of fabrics and films.

It is the purpose of this paper to illustrate a new modified flexometer which contains all the features mentioned above, which can be easily constructed, and which can be operated on a routine basis by individuals of moderate training.

Experimental Apparatus and Methods

Two different types of bending apparatus have been used successfully by the authors: one for fabric studies, the other for film evaluation. The bending system of the flexometer has been modified from a commercial testing device, the Tour-Marshall Tester used in ASTM Method of Test for Stiffness in Flexure of Plastics (D 747 – 50).[3]

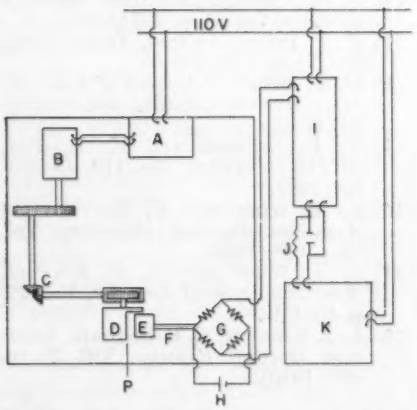

Fig. 1.—Schematic Arrangement of Flexometer.

Fabric Apparatus

The principal sections of the modified assembly shown in Fig. 1 are the electronic control, *A*, with reversing switch (Heller Co. GT-21 Motor Controller) for control of the bending motor, *B* (Bodine DC Motor), to actuate gear train *C;* two vises, *D* and *E*, to clamp the fabric, the first of which rotates the fabric around a given point and the second of which is connected to a lever arm, *F;* a 4-oz capacity Statham strain gage (Type YE-60), *G*, and a 1½ v battery *H;* an oscillator and amplifier, *I;* a General Electric Electronic recording milliammeter (300 μa full scale), *K*. A photograph of the entire assembly is shown in Fig. 2.

After clamping the sample in the vises and selecting the desired bending rate on the controller, the operator presses the push button which actuates the motor bending the sample around the axis of rotation. By reversing the switch, the same operation returns the fabric to its original position. The rate of bending is adjustable through a 20 to 1 range without gear train changes.

The following description of the experimental apparatus and technique is schematically represented in Fig. 1. The sample is bent around the axis of rotation, *P*, with clamp *D*. As the sample rotates around the axis *P*, it exerts pressure on clamp *E*, which in turn relays the force through a lever arm to the strain gage at *G*. The forces exerted by this deforming action alter the resistance characteristics of strain gage, *G*, and thereby cause a change in current from battery *H*, through the gage. This current is amplified by a Trimount Oscillating Bridge circuit and finally transmitted to a General Electric recording milliammeter (300 μa full scale). The distance between the two clamps of the bending mechanism is variable and allows for deformation of different size samples. In order to control the variation of distances between the two clamps, *D* and *E*, the strain gage *G* and lever arm *F* are mounted on tracks and can be moved horizontally. Vertical adjustment of this assembly also provides for parallel

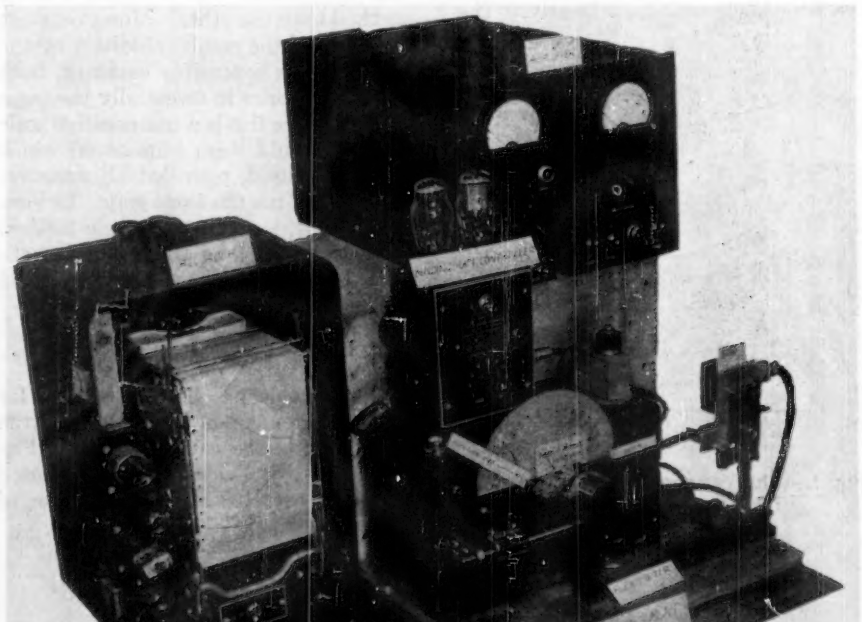

Fig. 2.—Recording Flexometer.

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[1] E. I. du Pont de Nemours and Co. Rayon Department.

[2] E. I. du Pont de Nemours and Co. Chemical Department.

[3] 1949 Book of ASTM Standards, Part 6, p. 578.

positioning of the two vises. The lever arm is light in weight and balanced on the knife edge by a threaded brass counterweight on the end opposite to the stationary vise. The movement of the arm depresses the strain gage which in turn measures the bending forces. The maximum movement of the strain gage is 0.0015 in.

Before inserting a sample into the clamps, the strain gage output to the recorder can be calibrated by hanging 1, 2, and 5-g weights on a small hook mounted below the lower jaw of vise *E*. From the known speeds of recorder paper and the bending rate, a calibration factor can be applied to the length of the trace on the chart paper to convert to degrees or radians.

The data for the illustrative experiments, described below, were obtained in 60 per cent relative humidity at 70 F. The sample size used was 1 by $\frac{1}{2}$ in. and bends were made perpendicular to the long direction. The data were obtained from bends of 60 deg at a rate of 3 deg per sec. The quoted values are averages for 5 different samples of a given fabric. All thickness measurements were made with an Ames gage calibrated in 0.1 mil.

Fabric Bending Modulus:

Bending takes place around an axis at the edge of the moving vise *P*, (Fig. 1). The equation (5) which appears to describe most accurately the type of bending produced is given by Eq 1 below, where *E* is the bending modulus, R_1 the reaction on the strain gage, *L* the span between vises, θ the bend in radians, *W* the width of the sample, and *t* the thickness. See Fig. 3 for schematic diagram.

$$E = \frac{2R_1L^2}{Wt^3\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

TABLE I.—BENDING MODULI OF FABRICS[a] DETERMINED WITH THE NEW FLEXOMETER.

	R_1, g	t, cm	E, kg per sq cm
Rayon, viscose process	0.28	1.37×10^{-2}	66
Nylon	0.50	1.90	44
"Acele" acetate rayon	0.14	1.32	36
Wool	0.30	3.68	3.7

[a] Fabrics were of approximately 150 warp ends, 80 picks, and of continuous filaments except for wool fabrics which were of spun yarn and 50 warp ends, 50 picks. Bending was performed against the filling threads.

Table I illustrates typical bending data for fabrics bent to an angle of 60 deg. Thickness values were determined by the method described in ASTM Specification D 76.[4] In addition to obtaining the bending moduli at 60 deg it is possible to bend samples from 0 deg to above 90 deg to obtain data

[4] Standard Specification for Textile Machines (D 76 – 49), 1949 Book of ASTM Standards, Part 5, p. 55.

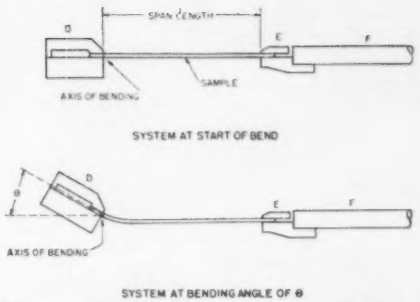

Fig. 3.—Schematic Diagram of Bending Tests.

from which the moduli can be calculated. As long as the curve is linear, the modulus will be independent of the degree of bend. However, if plastic flow occurs, the modulus should change with degree of bend.

Form Recovery and Work Recovery of Fabrics:

Another important fabric property that can be obtained is the degree of recovery of a sample from a given bend. The record shown in Fig. 2 is a typical bending and recovery curve for fabrics and illustrates the adaptability of the flexometer to measurements of this type. The recovery is easily calculated from the record of the bending cycle and results are comparable to those from tensile recovery investigations. Failure to reach zero bend for zero force during the recovery cycle is evidence of the occurrence of secondary creep.

Determination of the fabric property similar to primary creep is equally simple with the new flexometer. If the work input exceeds the work returned during the cycling process, the per cent of work recovered will indicate how much primary creep has taken place. Measurement of areas under the two curves provides data of work input and return. Also, the variations of these recovery properties with degree and rate of bending are informative. Finally, the recovery power of samples can be studied at specifically defined rates of bending, rates of recovery, degree of bending, and holding time before recovery.

PLASTIC AND PAPER APPARATUS

The technique used to measure fabrics as described above cannot be used when bending measurements are desired on plastic film or paper. These materials bend in an S-shaped form when bent under conditions as outlined above. This is probably due to the fact that they do not "drape" as do fabrics. Such a system produced nonlinear force-angular curves that could not be used easily for calculating bending modulus.

Preliminary bending trials with film or paper clamped at one end and bent against an anvil produced linear force-angular curves that could be calculated for the modulus of bending in pounds per square inch.

The recorder described in above section was thought to have too small a chart for the measurement of small bending forces, and it was considered desirable to have rectangular coordinate chart paper rather than the chart system as used on the General Electric recorder.

Accordingly, a bending system was built (see Fig. 4) where the sample was clamped only by the rotating vise, one end of the sample being free to press against an anvil mounted on the end of the strain gage weighing arm.

Since the bending forces encountered here were extremely small, it was necessary to use a high-resistance type strain gage, Statham type G1-4-800, which operates at an input voltage range of 0 to 15 v dc. The output signal from the gage was fed into a Brown 10-mv recording potentiometer which contained a high gain amplifier. This amplifier

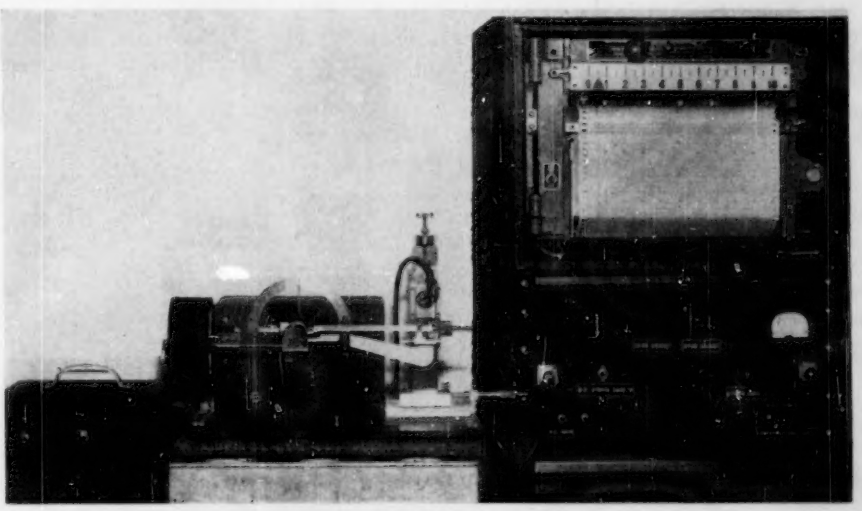

Fig. 4.—Plastic and Paper Flexometer.

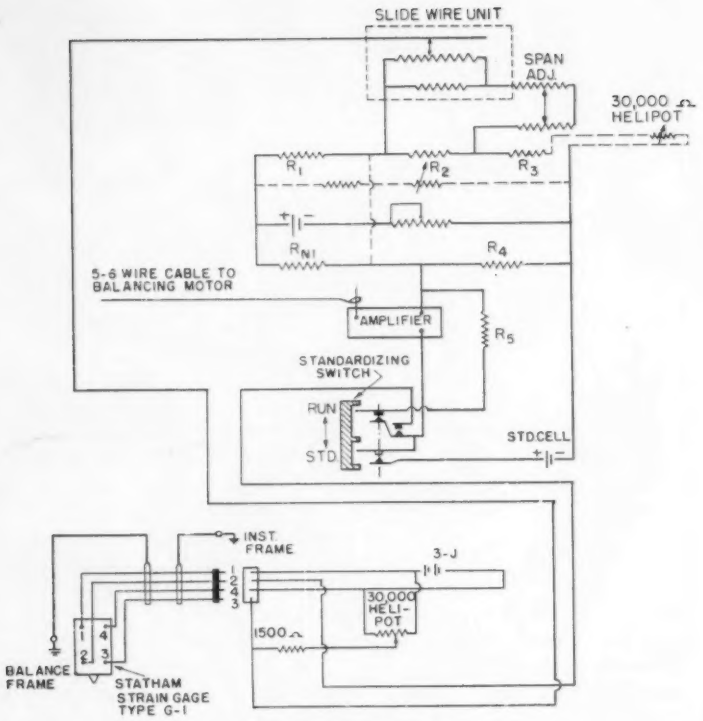

Fig. 5.—Flexometer Circuit.

was found necessary to enable the full load range from 100 mg to 5 g to be recorded full scale on the recorder. A zero control, a 30,000 ~ helipot, was placed across the strain gage. The circuit of the Brown recorder was adjusted to cover the full output range of the strain gage which was found to be 0.1 to 5.0 mv. This was done by eliminating the input condenser in the recorder and by augmenting the resistor R_3 by a 30,000 ~ helipot (Fig. 5). This change enabled different widths of record on the chart for various loads applied to the weighing beam. It became necessary to add resistors in parallel to the upper branch of the circuit to maintain a current flow of 4 ma; these values were of 250 ~ and 1000 ~, respectively. Since it was undesirable to have automatic standardization on the recorder, this feature was removed and replaced by a manual standardization arrangement. The electrical circuit is shown in Fig. 6.

The mechanical advantage obtained by the weighing beam was 17:1. Since the maximum movement of the strain gage was 0.0015 in., the movement of the bending anvil under full load became 0.0255 in. Since this movement would cause serious difficulties, the actual depression of the beam under various loads was accurately measured and plotted. Thus, for any load, the depression of the beam was known.

The equation which best describes the bending action is given below (5).

$$E = \frac{4FL^2}{bd^3(\theta - \phi)} \quad \ldots\ldots\ldots (2)$$

where:

F = bending force in lb,
E = stiffness in psi,
b = width in in. of sample,
d = thickness in in. of sample,
θ = observed bending angle in radians,
ϕ = angle subtended by beam drop in radians (see Fig. 6), and
L = span length in in.

From Fig. 6, it is seen that the measured angle θ is not the true angle of bend since the beam depresses an amount a according to load during bending. By measurement of the amount of this drop, a, the tangent of angle ϕ can be calculated easily and thus ϕ is determined.

The results obtained in Table II were made at 50 per cent relative humidity and 77 F and are the average values for 10 determinations. The sample size was $\frac{1}{2}$ by $\frac{1}{2}$ in., and bending trials were made in both the machine and cross direction of the samples. The modulus calculations were made from a 20-deg bend, although the force-angular curves were linear in this region, thus allowing the calculation to be successfully made at any bending angle up to as high as 60 deg. The bending rate used for these tests was 1-deg bend per sec. The span length used was $\frac{1}{4}$ in.

TABLE II.—BENDING MODULI OF VARIOUS PLASTICS OBTAINED BY THE NEW FLEXOMETER.

	Bending Modulus, psi
450 gage plain cellophane	842 000
2 mil cellulose acetate	201 000
140 gage "Pliofilm" rubber hydrochloride	95 000
1.5 mil polythene	18 000
2 mil "Butacite" polyvinyl butyral resin unplasticized	205 000

There are limitations as to the type of sample and length of span that may be used in stiffness studies made on this type of equipment. The maximum thickness of sample seems to be about 3 mils. Measurements made on samples of greater thickness than 3 mils do not seem to follow Eq 2 but follow a rather complex function. The same condition ensues when span lengths smaller than 0.100 in. are used.

Other Statham strain gages which allow a range of full-scale values on the recorder up to 30 g have been used successfully. These ranges are necessary to allow measurements of high modulus type films that are 2.5 to 3.0 mils in thickness.

Summary

A new improved electronic flexometer for measuring bending properties of fabrics and plastic films is described. The flexometer contains a measuring element which undergoes little motion during the bending cycle, a variable but controlled bending rate, and an electronic recording device which enables a permanent record to be obtained. It is

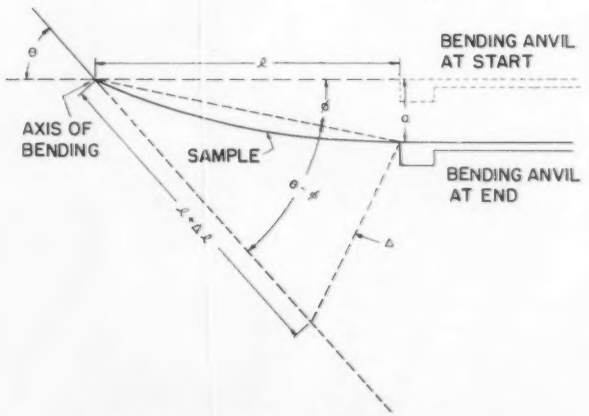

Fig. 6.—Angle Subtended by Beam Drop.

adaptable for the determination of bending modulus, variation of modulus with degree and rate of bending, elastic and creep recovery, and variation of recovery properties with degree and rate of bending.

Acknowledgment:

The authors wish to acknowledge the assistance given by L. P. Haner, J. T. Rivers, R. M. Hoffman, H. L. Rash, and T. J. Uhrig in the development of the techniques described in this paper.

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An Analysis of the Effect of Particle Interlocking on the Strength of Cohesionless Soil*

By B. K. Hough[1]

SYNOPSIS

The paper presents an account of experiments so conducted as to permit independent evaluation of shearing resistance due to sliding friction and that due to particle interlocking in granular soil. The conclusion is reached that ultimate or frictional resistance alone should be the standard basis for the reports of testing laboratories and that the additional resistance due to interlocking be used only at the discretion of the designer.

THE shearing strength of soil is generally attributed to frictional resistance to sliding developed at points of interparticle contact along what are known as failure surfaces within the soil mass. This concept is seemingly most applicable to cohesionless soil and for such material may be expressed in the simplified form of the Coulomb relation:

$$s = p \tan \phi \quad \ldots\ldots(1)$$

where:

s = shearing strength defined as the tangential stress at failure on an internal failure surface,
p = (effective) interparticle stress normal to the failure surface, and
ϕ = internal friction angle or angle between resultant and normal stresses on the failure plane.

Despite the widespread acceptance of this relationship, there is still some difference of opinion as to the meaning of each term and the conditions under which the equation may be used. The following discussion relates in particular to the meaning of the term "failure" when applied to a granular material under shearing stress and the nature of surfaces on which failure occurs. This discussion leads to consideration of the possible range of values which may be assigned in engineering practice to the friction angle of cohesionless soil and in turn to calculation of shearing strength.

In some respects it is convenient to discuss shear in soil with reference to behavior of the material during a direct shear test. The conventional type of equipment for this test is so constructed as to give the impression that shear occurs on a single plane with a predetermined position and orientation in the specimen under external forces applied in directions which are respectively normal and tangential to this plane. With such equipment, tests are conducted in a manner intended to permit simultaneous measurements of the terms s and p in Eq 1 and hence evaluation of ϕ. The usual procedure is to apply and maintain a constant vertical load on the device while a steadily increasing horizontal force is exerted and is taken as a measure of specimen resistance.

To utilize the data obtained from such a test for evaluation of ϕ, it becomes necessary first to establish a convention as to what is meant by failure. In this connection the variation of the shearing force with horizontal displacement of the upper half of the specimen relative to the lower is customarily used as the basis for a type of stress-strain diagram. The horizontal or shearing stress represented in such a diagram is usually calculated by dividing the externally applied horizontal force by the area of the specimen. Quite often the nominal or original specimen area is used in calculating shearing stresses even after a relative horizontal displacement amounting to 10 to 20 per cent of the original length of specimen.

EFFECT OF DENSITY

Two diagrams of this type are presented in Fig. 1, one for a sample of cohesionless soil which initially had a very dense packing, the other for an initially loose specimen of the same identical material. Specimens in intermediate conditions of initial density would be

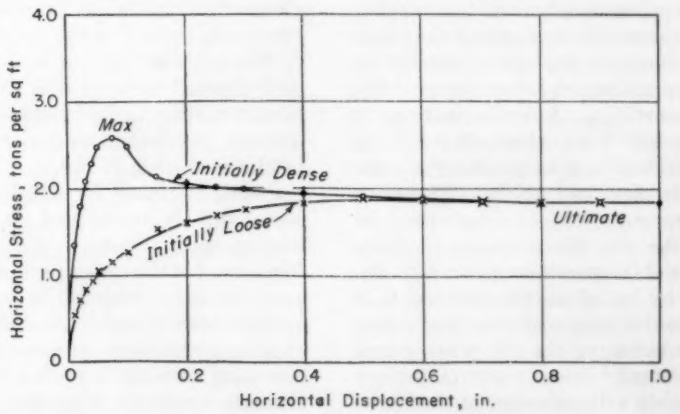

Fig. 1.—Stress-Strain Data from Conventional Type Direct Shear Test Under Constant Vertical Load.

Vertical stress = 3 tons per sq ft; original sample length = 4 in.

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* Presented before a meeting of Committee D-18 on Soils for Engineering Purposes held in Cincinnati, Ohio, March 8, 1951

[1] Professor of Civil Engineering, Cornell University, Ithaca, N. Y.

represented by curves lying between these two. These diagrams illustrate the generally familiar fact that if the specimen is initially very dense, the shearing stress, when calculated as described above, increases gradually to a maximum value and then decreases to a significantly lower value usually indicated as being essentially constant and referred to as the ultimate. There is apparently ample justification in this representation for considering that the specimen fails at the point when its maximum resistance is overcome; hence it is quite common to report the shearing strength of soil, that is, the term s in Eq 1, as the maximum shearing stress obtained during test in the manner described above.

The initially loose specimen also gradually develops shearing resistance as the horizontal force is increased, but its resistance does not significantly decrease after the maximum value is reached. Notable too, as well as generally familiar, is the fact that the maximum resistance of the loose specimen is considerably less than that of the dense specimen, being approximately equal to the so-called ultimate value for the latter.

True Friction Angle

If shearing strength under a specified normal stress is to be defined as maximum shearing resistance, it appears that material in a very dense condition has greater strength than when it is loose, and further, that the angle of internal friction of material when very dense is appreciably greater than when it is loose. For example, values of ϕ ranging with initial density from $28\frac{1}{2}$ to 35 deg have been reported for soil with rounded particles, 34 to 46 deg for soil with angular particles. Since no significant alteration of particle surfaces is considered to occur during shear in either loose or dense specimens under ordinary loads, these findings are in apparent conflict with the concept that strength is due simply to sliding friction, it being generally recognized that friction coefficients depend primarily on the composition and condition of the sliding surfaces. A reconciliation of concepts has been attempted by the author on the basis of results of the experiments described below. These experiments suggest that what may be termed the true friction angle of cohesionless soil is essentially a constant unaffected by initial soil density but that during initial stages of shearing action the orientation of the plane on which sliding actually takes place may vary considerably with reference to the direction of the externally applied forces. Thus, in dense soils there is developed to some extent not only sliding friction but the shearing resistance of individual solid particles as well. This additional strength may be and often is referred to as strength due to interlocking. It seems evident that it is not and cannot be developed in loose soils, thus suggesting that the so-called true friction angle and the angle determined from conventional tests on loose material should be approximately equal.

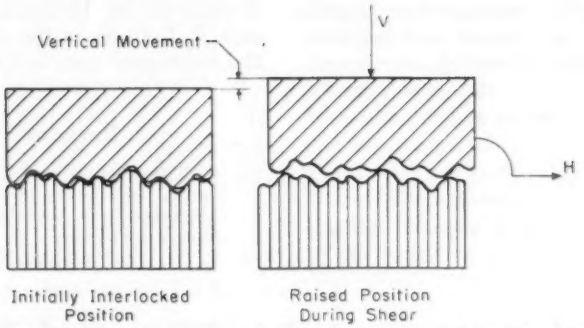


Fig. 2.—Idealized Model of Upper and Lower Parts of Specimen During Direct Shear Test.

Vertical Movement

The concept of change in orientation of sliding surfaces during shear is based on fairly well-established fact. Although the direct shear device is seemingly constructed with the intent of compelling the specimen to fail on a single horizontal plane, it is well known that the upper half, if permitted to do so, may move in a vertical as well as horizontal direction, thus indicating that movement occurs along a generally inclined shear plane. With an initially dense specimen, the vertical movement is such as to move the upper half of the specimen upward even under considerable vertical load, with a loose one to lower it. Although it is true that such movement might seem to reflect a certain amount of over-all change in density of the entire specimen without influence on the orientation of the failure plane, it is considered more likely, at least in very dense specimens, to reflect a localized movement in the immediate vicinity of the zone of shear. Some years ago, in fact, it was pointed out by A. Casagrande,[2] that in dense materials such upward movement is necessary to permit sliding rather than fracture of initially interlocked particles as shown in idealized style in Fig. 2. With loose material, the need for some downward movement is recognized to maintain intergranular contact during shear. Movement of the upper part of the specimen is usually observed to be along an inclined path to and beyond the point of maximum resistance in dense specimens, becoming essentially horizontal only as ultimate resistance is reached. In loose specimens, downward movement is usually observed to continue until maximum strength is reached.

When movements in the zone of shear are of interest as in this particular investigation, the direct shear testing device, despite its well-known limitations, offers many advantages over the triaxial device, for example, in which the location of slip planes cannot be observed at all during initial stages of test. Accordingly, the direct shear device was used exclusively in these studies, certain tests being conducted by conventional methods, others for comparative purposes, by specially devised methods.

The material on which experiments were made was a composite of various natural sands blended to obtain a somewhat idealized gradation as shown in Fig. 3. Range of particle sizes was from approximately 2.0 to 0.05 mm, the range for the Sand classification of the U. S. Bureau of Soils. The material was generally tested in a moist condition to eliminate difficulties due to spillage at the front of the box which were experienced during tests on dry specimens. The direct shear device used in these tests was of conventional design constructed to hold specimens 4 by 4 by $\frac{3}{4}$ in. in size.

Relation Between Vertical and Horizontal Stresses

In planning the previously mentioned special tests, it was recognized that if at any time sliding occurred on inclined planes, the externally applied vertical and horizontal forces would no longer be respectively normal and tangential to the slip planes. The relation between vertical and horizontal stresses and normal and tangential stresses on slip planes, illustrated graphically in Fig. 4, may be expressed as follows:

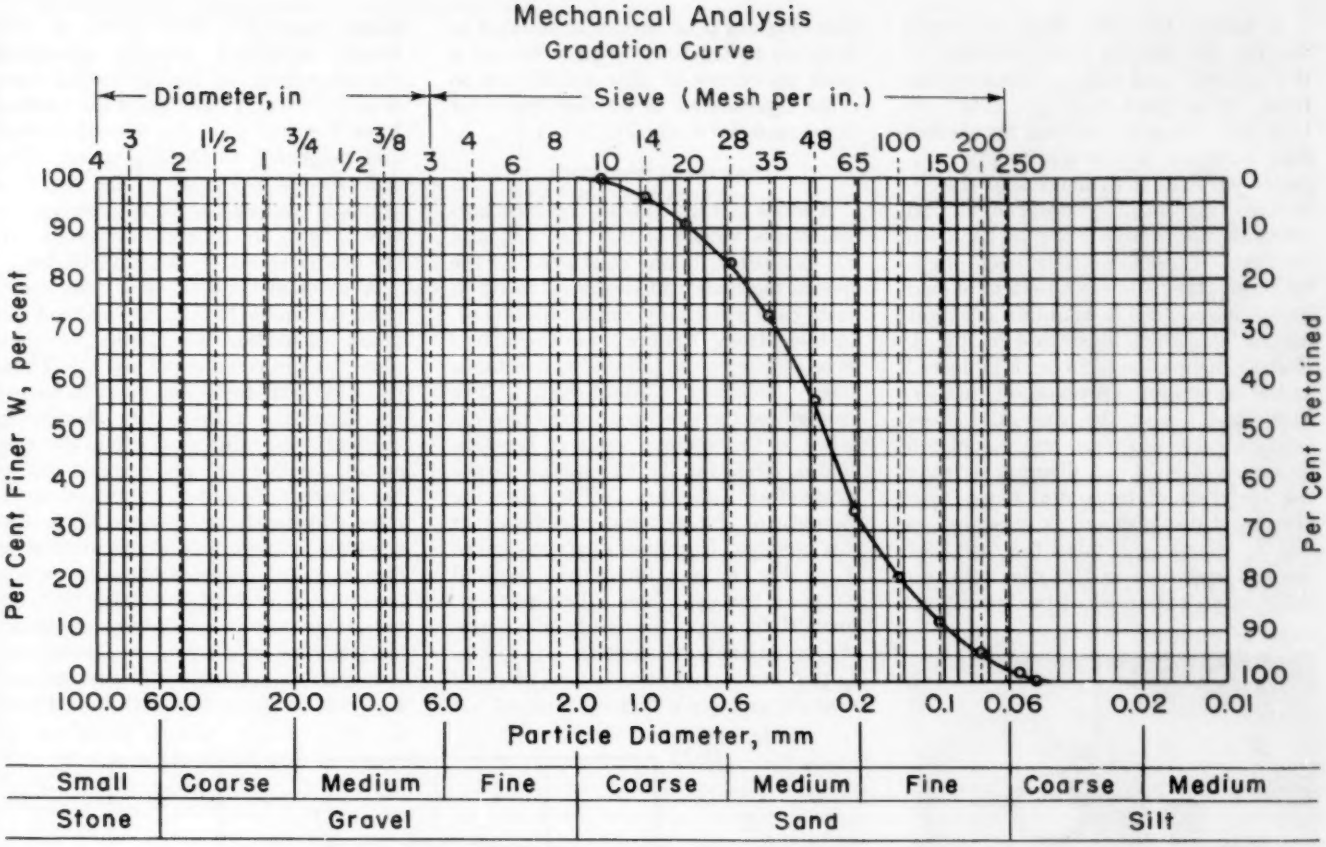
$$\sigma = p \cos\theta + s \sin\theta \quad \ldots\ldots (2)$$

$$\tau = s \cos\theta - p \sin\theta \quad \ldots\ldots (3)$$

where:

σ = normal stress on slip plane,
τ = tangential stress on slip plane,
p = vertical stress due to force V,
s = horizontal stress due to force H, and
θ = angle of slip plane with horizontal.

[2] *Characteristics of Cohesionless Soils Affecting the Stability of Slopes and Earth Fills*, Publications from the Graduate School of Engineering, Harvard University, No. 173, 1935–1936.



Soil Classification

Fig. 3.—Mechanical Analysis of Material Used in Tests.

These equations emphasize the fairly evident fact that if the slip plane is inclined in a direct shear test the normal and tangential stresses on the slip plane are affected by both horizontal and vertical applied forces. Maintaining the vertical force constant under these conditions as is customary in such tests will, therefore, not produce a constant normal stress on the slip plane as intended. In fact, it appears that if a constant normal stress is required, the vertical force must be varied both with H and θ as long as θ has a value other than zero.

Maintenance of a constant normal stress during each test was desired in the special experimentation although it was realized that the requisite variation of vertical force with conventional shear testing machines might be difficult. Conventional machines for such tests commonly utilize dead weights for vertical loading either with or without some form of mechanical advantage. Thus they serve very well for their intended purpose of maintaining constant vertical load but are poorly adapted to rapid variation of load. A newly developed testing machine[3] incorporating a pneumatic vertical loading system as illustrated in Figs. 5(*a*) and (*b*) became available, however, at the time of this investigation, and being better adapted for load variation was utilized for the special tests in this research although for conventional tests which were also conducted, standard platform scale equipment was used.

Contact Area

In addition to the need for vertical load variation occasioned by change in slip plane orientation, consideration was given to the effect of change in contact area which occurs in most conventional testing devices of the direct shear type. Even if the slip plane remained truly horizontal throughout each test, the normal stress would steadily increase rather than remain constant under a constant vertical force as contact area decreased. If the ratio of the external forces H and V in a single test is taken as establishing the tangent of the friction angle or if it is assumed that for a series of tests the rupture envelope is a straight line (representing Eq 1), changes in contact area may be disregarded. In the proposed special testing, however, a steady decrease in vertical load to compensate for decrease in sample area seemed desirable and was provided for.

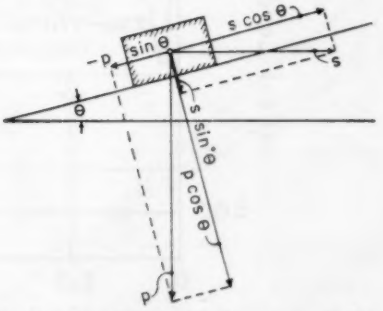


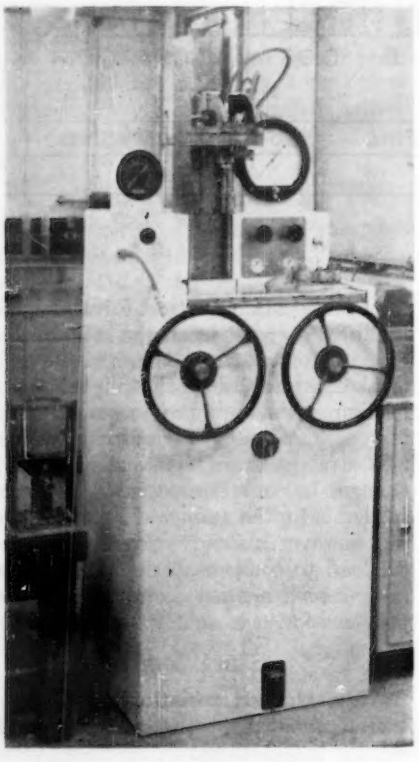
Fig. 4.—Resolution of Forces on Sliding Mass.

Slip Plane

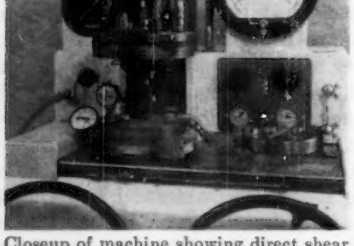
Although load variation to compensate for change in contact area could readily be scheduled in advance, variation for other purposes required foreknowledge of slip plane orientation throughout each test. Preliminary investigations to obtain this information were scheduled therefore, the first such studies being made with initially dense specimens ($e = 0.23$). The procedure followed was first to conduct a test in purely conventional fashion, with vertical force maintained constant while movement of the upper part of the testing device was observed and the horizontal force measured. A tentative schedule for variation of the vertical force was then prepared on the basis of these data and Eq 2 above.

[3] B. K. Hough, "A Universal Loading Machine for Engineering Tests on Soils," ASTM Bulletin, No. 170, December, 1950, p. 44(TP 270).

A second test was then performed varying the vertical force according to this schedule and making new observations. By a repetition of such tests, each time with a revised schedule for vertical load variation, a test was finally completed which gave evidence that the objective of maintaining a constant normal stress on the surfaces of sliding had been reached. The change in slip plane orientation and the manner and extent of load variation required to maintain constant normal stress are illustrated in Fig. 6. Here an inclination of 10 deg is indicated as the maximum slip plane inclination. From such a test, the tangential stress acting on the slip plane was calculated by means of Eq 3. A diagram showing the variation of tangential stress with horizontal displacement is presented in Fig. 7. Keeping in mind the fact that the test specimen in this case was initially in an extremely dense condition, this diagram is of particular interest as it shows no tendency to pass through a peak as curves of this nature are so often represented to do (see curve for dense material in Fig. 1).



(a) General view.



(b) Closeup of machine showing direct shear device in testing position.

Fig. 5.—Universal Loading Machine Used in Tests.

Shearing Strength

A series of such tests at constant normal stress values of 0.5, 1.0, 3.0, and 6.0 tons per sq ft was conducted by the special methods just described using in each case extremely dense specimens. In these tests, "failure" was considered to be reached when full sliding resistance was definitely established. The strength of the specimens was therefore taken as the average value of the tangential stress for the flat section of the stress-strain diagram. The shearing strength of the material established in this manner is represented by curve *A*, in Fig. 8 as a function of normal stress on the slip plane. For contrast, curve *B*, based on the results of a series of conventional tests is also shown in Fig. 8, this curve reflecting so-called peak strength and peak friction angle of the dense material. This curve, as previously explained, actually represents the magnitude of the horizontal force *H* at failure as a function of the vertical force *V* rather than the stresses normal and tangential to the slip plane. The difference in the slope of the two diagrams is sufficient to be of practical interest, being the difference between values of approximately 41 and 34½ deg.

A series of tests on very loose specimens conducted to take into account slip plane orientation was desired to complete the projected experiments. Theoretically such tests could be conducted by increasing rather than decreasing vertical load during initial shearing strain. However, as perhaps might have been anticipated, it proved to be impossible with loose material to distinguish between downward movement due to consolidation of the entire specimen under vertical load and that attributable solely to sliding on downward sloping failure planes. Tests were, however, conducted by conventional methods on specimens with initial void

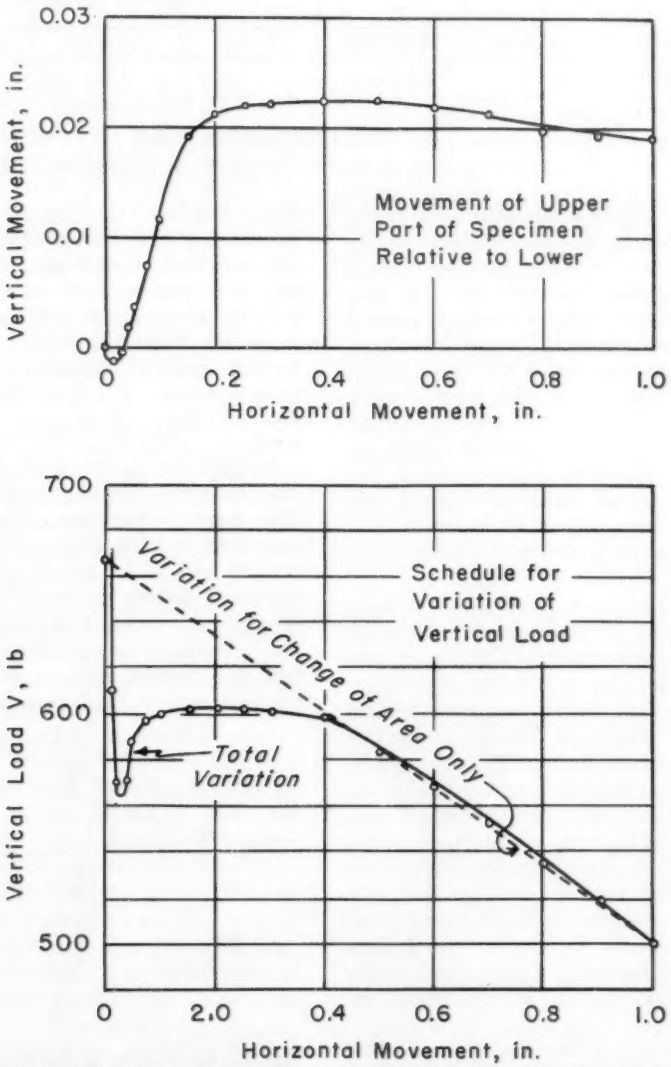


Fig. 6.—Basis for Variation of Total Vertical Load During Special Direct Shear Tests.

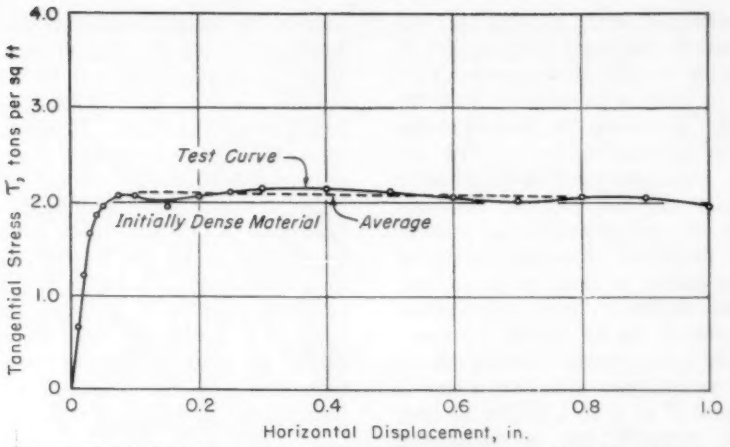


Fig. 7.—Stress-Strain Data from Special Type Direct Shear Test Under Constant Normal Stress. $\sigma = 3$ tons per sq ft.

ratios of approximately 0.68 which seemed to be about as loose as could be managed. The results of these tests are also shown in Fig. 8, curve *C*, using the same conventions in plotting results as with conventional tests on the dense specimens. The difference in the slopes of $34\frac{1}{2}$ and 33 deg for curves *A* and *C* is not much, if any, greater than the experimental error of the test.

For further information, the strength of the initially dense samples at so-called ultimate rather than peak resistance in the conventional tests is presented as curve *D* in Fig. 8. This curve with a slope of $32\frac{3}{4}$ deg and curve *C* for the loose specimens are for all practical purposes identical.

Determination of True Friction Angle

Thus it appears from the agreement of curves *A*, *C*, and *D* that when the slip plane is essentially horizontal and when initial density has changed to the so-called critical value, sliding friction is the only type of resistance acting, and a friction angle dependent only on the composition and condition of the sliding surfaces is developed. It is the friction angle developed under these conditions that the author refers to herein as the true friction angle. For the material used in the above-described studies it could be reported as $33\frac{1}{2}$ deg with an indicated accuracy of approximately ± 1 deg regardless of specimen density. The value $33\frac{1}{2}$ deg, incidentally, is exactly equal to the angle of repose of the material in a dry condition.

Under certain circumstances, determination of the true friction angle might seem to be of greater academic than practical interest. If the total shearing resistance of granular material is desired and if strength due to interlocking will surely contribute to such resistance, the use of peak strength as previously defined seems clearly justified whether calculated by use of a peak friction angle or by some other method. The danger of determining and reporting friction angles higher in magnitude than the true angle, however, lies in the fact that such data can so readily be misused. It seems that soils testing laboratories are increasingly expected to report test data with no knowledge of the conditions under which they may be applied. The additional strength due to interlocking which is as previously stated, a partial development of the resistance to fracture of the solid particles themselves, is available only when shearing strains are less than those at which peak strength is developed. In direct shear tests, this amounts to a displacement of approximately 0.1 in. in a sample of 4-in. original length or a linear strain of about 2.5 per cent. Once this strain is exceeded, reduction in resistance is so rapid that testing machines without provision for almost instantaneous decrease of shearing force are incapable of adjustment which will permit evaluation of residual or ultimate strength. In many cases, the technicians or soils engineers responsible for the tests—even with full knowledge of field conditions—would find it difficult, if not impossible, to decide whether strains in the proposed structure would exceed 2.5 per cent or not. It would, therefore, seem wiser to adopt as a standard, the practice of reporting the true friction angle of cohesionless soils plus an additional factor of some sort which could be used by the designing engineer at his own discretion to estimate strength due to interlocking.

Interlocking Effect

Before discussing methods for separate evaluation of interlocking strength and frictional resistance, it may be well to consider situations when interlocking contributes materially to total strength. Conceivably the most extreme illustration would be a case where angular pieces of cut or broken stone are treated as soil particles for purposes of determining shearing strength. Such material may be laid up or placed in an unusually dense condition and as long as it remains in such condition, as in a wall, for example, it no doubt develops shearing strength far in excess of that dependent solely on sliding friction between individual pieces. Angular particles such as crushed rock, especially when confined as by a slab or pavement, can evidently develop considerably greater strength than finer soil, even when mineralogically the soil and rock are identical. Thus, when an exceptionally high density can be assured by special packing or when a reasonably dense material is in any way confined by a structural element, thereby limiting strain, strength due to interlocking may be considered. In unconfined slopes of natural soil, however,

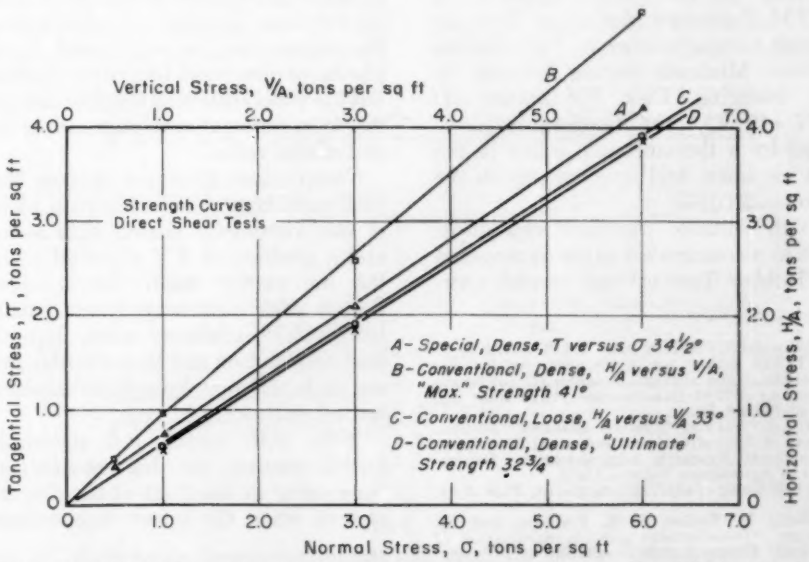


Fig. 8.—Graphical Comparison of Results from Conventional and Special Direct Shear Tests.

whether in cut or fill, and in most soil formations serving as foundations, dependence upon strength due to interlocking would seem to involve a serious risk. For many such cases, conservative design might well be based on use of strength due to friction only.

Summary

It seems reasonable and logical, therefore, to propose that shear testing be conducted only with machines capable of measuring ultimate as well as peak strength in cohesionless soils and to require that ultimate strength and true friction angle be reported in every case, never peak strength alone. If and when occasion warrants, there should be no objection to reporting peak strength and indicated peak friction angle in addition, either for an initial density representing 100 per cent relative density or for a specified initial density.

Direct or translatory shear testing devices in which there is no possibility of interference with movements perpendicular to the shear plane appear to be suitable for the recommended tests if used in loading machines having the necessary provision for instantaneous reduction of shearing force. The frequently employed proving rings serve excellently for this purpose although they are not necessarily the only feasible device. Machines which apply shearing force by means of dead weights, however, can seldom if ever be adjusted rapidly enough for the desired purpose.

Triaxial testing devices are considered equally satisfactory when constructed and operated so that ultimate as well as peak strength can be measured. This requires rapid load adjustment at peak strength and continuous measurement of the changes in specimen area.

Conclusion

In conclusion and by way of summary, it is considered justifiable to state that shearing strength of cohesionless soil may under certain conditions be a combination of interlocking strength and frictional resistance rather than sliding friction alone as the Coulomb formula might seem to indicate. However, since strength due to interlocking is available only within relatively narrow limits of initial shearing strain and exists in the field under conditions which can seldom be established by the testing engineer, it is considered advisable to make a standard practice of reporting shearing strength in terms such that the responsibility for using strength values greater than true frictional resistance must be assumed by the designing engineer.

Acknowledgment:

The author is greatly indebted to Pierre Richon Foss, former graduate student at Cornell University, who performed most of the experiments on which the paper is based, and to Gustave Young, Instructor-Technician in Soils Engineering at Cornell.

Temperature Measurements in the Mooney Viscometer

By Rolla H. Taylor[1] and William P. Ball[1]

One of the chief difficulties in obtaining the proper cure curve for a rubber stock in the Mooney viscometer is due to the inadequacy of the methods available for the control and measurement of the temperature of the test specimen. The purpose of this paper is to discuss briefly the reliability of the various methods and to show the relationship between the temperatures indicated by the thermocouples conforming to the design specified in ASTM Tentative Method of Test for Curing Characteristics of Vulcanizable Rubber Mixtures During Heating by the Shearing Disk Viscometer (D 1077 – 49 T),[2] the temperature indicated by a thermocouple coiled in the test specimen, and temperatures in the platens and dies.

With suitable auxiliary equipment such as recommended in the Symposium on Rubber Testing[3] and careful operation, equilibrium temperatures may be maintained within ±0.5 F. Measurement of the temperature of the test specimen during normal testing procedures is not so simple, however. This temperature varies from the cool temperature of the sample (usually room temperature), at the instant the machine is loaded, to some equilibrium value which depends on the viscosity characteristics of the specimen as well as the temperature of the machine parts. At first hand it appears that measuring the temperature at some point in the platens or dies would be a better method, but the widely different temperature gradients in different machines makes this of doubtful value.

Temperature gradients of more than 10 F have been observed in each platen of one viscometer heated with steam, and a gradient of 3 F observed within the die cavity itself. In machines heated with electricity, much smaller temperature gradients exist, but the heat distribution and heat-transfer path are quite different from those machines heated with steam.[4]

With both steam and electrically heated platens, the highest temperatures occur at the front of the dies and platens while the lowest temperatures occur at the back. This has been found to be true on all machines investigated by one of the authors.[4] Unfortunately, the gradients from the front to the back of the platens and dies have not been found to vary in a straight-line function nor have they been found to vary uniformly from one machine to another. These conditions make it virtually impossible to select an individual control point in each platen or die and expect to obtain a standard relationship between temperatures at the control points and the actual temperature of the test specimen for different machines. For control purposes, however, where one is concerned only with correlating the results obtained with a given processing unit, a control point in the platen or dies should be satisfactory, provided it is sufficiently sensitive to insure uniform temperatures in the die cavity.

From an analysis of the foregoing argument, it appears that a better method of insuring standard condition from one machine to another and for indicating deviations from standard conditions is by means of thermocouples in the die cavity. The design specified in the Tentative Method D 1077 – 49 T[2] is based on considerable data and on a careful study of the problems involved and is, in the opinion of the authors, the best method currently available despite certain of its undesirable features.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] U. S. Natural Rubber Research Station, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, Department of Agriculture, Salinas, Calif.

[2] 1949 Book of ASTM Standards, Part 6, p. 1239.

[3] Rolla H. Taylor, J. H. Fielding, and M. Mooney, "Development and Standardization of Tests for Evaluating Processibility of Rubber," Symposium on Rubber Testing, p. 36, Am. Soc. Testing Mats. (1947). (Symposium issued as separate publication, STP No. 74.)

[4] Reference is made to unpublished work carried out at the National Bureau of Standards.

Test Apparatus

The Mooney viscometer used in the present work was an electrically heated N. B. S. model with the top platen insulated. The insulation consisted of approximately $\frac{3}{8}$ in. of asbestos paper with a No. 22-gage galvanized metal shield which extended below the bottom die. The heating controls recommended in the Symposium on Rubber Testing[3] for electrically heated machines were used throughout the tests. In addition, however, a 50-ohm resistor and a 0.002 μf capacitor were connected in series across the terminals of each of the thermal regulators to prevent chattering of the relays.

Temperature measurements were made in three ways: (1) Platen temperatures were measured with standard 160 to 360 F platen thermometers. (2) Die-cavity temperatures were measured with thermocouples in plungers corresponding to the design given in Tentative Method D 1077 – 49 T. Leeds & Northrup[5] No. 30 duplex glass-covered copper-constantan thermocouple wire was used throughout, and the insulating bushing was made from laminated bakelite rod. (3) Die temperatures and temperatures measured in the test specimen with the coiled thermocouple were measured with No. 30 glass-covered copper-constantan thermocouple wire with a plain silver-soldered junction. The arrangement of the thermocouples in the dies is illustrated in Fig. 1. Small grooves were cut in the shoulders of the dies to accommodate the thermocouple wires so that they would not be cut by the die holders. The thermocouple wires were then brought out beneath the die holders to the potentiometer. A cold junction at 32 F was used with all thermocouples and a Leeds & Northrup thermocouple switch was used to switch from one thermocouple to another. The electromotive force produced by each thermocouple was read by means of a Rubicon portable precision potentiometer.

Procedure and Results

In order to give as complete a picture as practical of the temperature relationships in the Mooney viscometer, six different series of tests were made. They were tests to show (1) the relationship between the equilibrium temperatures indicated by the front and back plunger thermocouples with the machine empty; (2) the relationships between the temperatures indicated by the front and back plunger thermocouples with rubber in the machine but with the machine not running; (3) the relationship between the temperatures indicated by the plunger thermocouples and by a thermocouple coiled in the test specimen with the machine not running; (4) the relationship between the equilibrium temperatures in the die cavity and around the dies with the machine empty ("die cavity temperature" is used to denote the temperature indicated by the plunger thermocouples when they are connected in parallel); (5) the relationship between die and die-cavity temperatures during normal testing; and (6) the relationship between variations in cure characteristics with variation in platen temperature. It was necessary to arrange the testing in this manner because of the limited amount of data that could be taken during any one test with the equipment and manpower available.

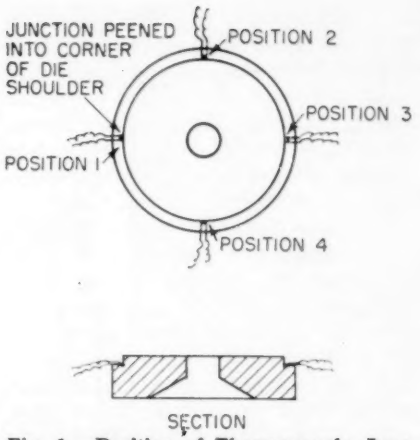


Fig. 1.—Position of Thermocouple Junctions in Measuring Temperature of Dies in Mooney Viscometer.

All tests, with the exception of the ones to show the effect of variation in platen temperatures, were made at "equilibrium test temperatures" as defined in ASTM Tentative Method D 1077 – 49 T, of 212 and 287 F. The value of 212 F is the one normally used in making viscosity tests of crude rubber, and the value of 287 F was arbitrarily chosen because it is the temperature at which test sheets are cured in this laboratory. The machine was brought to the test temperature before the beginning of each test. Platen temperatures, taken with each test, were estimated to the nearest $\frac{1}{4}$ F and were read with the aid of a reading glass. Thermocouple readings were estimated to the nearest $\frac{1}{10}$ division on the potentiometer, which was equivalent to 0.001 mv.

In making tests to show the effect of variation in platen temperatures, the machine was brought to the "equilibrium test temperature," and three different sets of conditions were employed: (1) Tests were made with the temperature of the top platen maintained approximately 4 F above the temperature of the bottom platen, and with the platen temperature adjusted so that the temperature curve as determined from the plunger thermocouple readings was essentially the same as the curves obtained during normal tests with the platen temperatures equal and with a test temperature of 287 F. (2) The above procedure was repeated except that the temperature of the bottom platen was maintained approximately 4 F above the temperature of the top platen. (3) Tests were made at test temperatures of 282, 287, and 292 F, with the platen temperatures equal.

Preliminary work indicated that very careful procedures would be necessary if the measurement of the temperature of the test specimen with the coiled thermocouples were to give reliable results. Consequently, tests were made on both crude and cured test specimens in the following manner: With both plungers in place and fastened down, the crude test specimens were preformed and the compounded specimens cured in the viscometer. These specimens

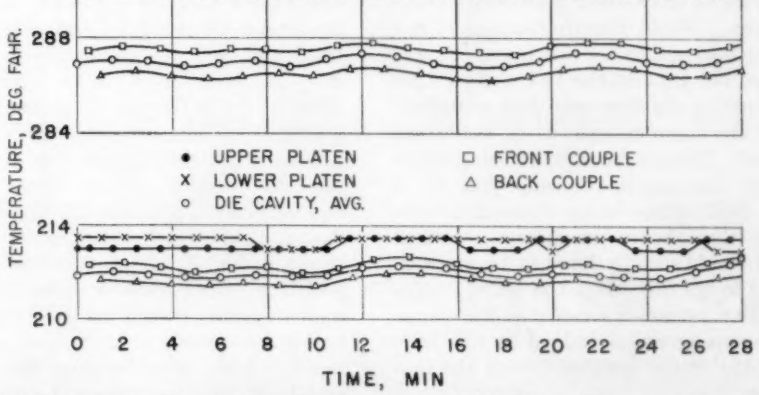


Fig. 2.—Equilibrium Temperature Relationships of the Platen Thermometers and the Plunger Thermocouples in the Mooney Viscometer—Machine Closed, Empty, and Not Running.

[5] Mention of special equipment or materials in this paper does not imply they are endorsed or recommended by the Department of Agriculture over others of a similar nature not mentioned.

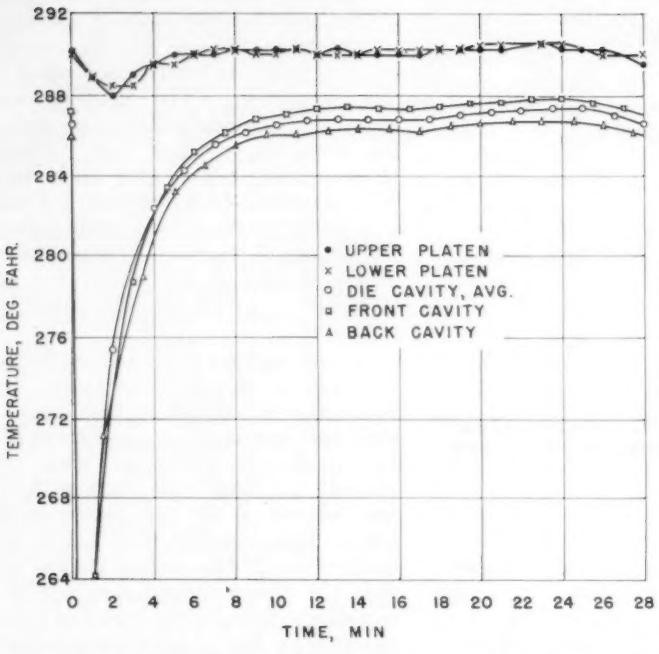


Fig. 3.—Effect of Loading Mooney Viscometer with Sample at Room Temperature on the Platen Thermometer and Plunger Thermocouple Temperature—Machine Closed and Not Running.

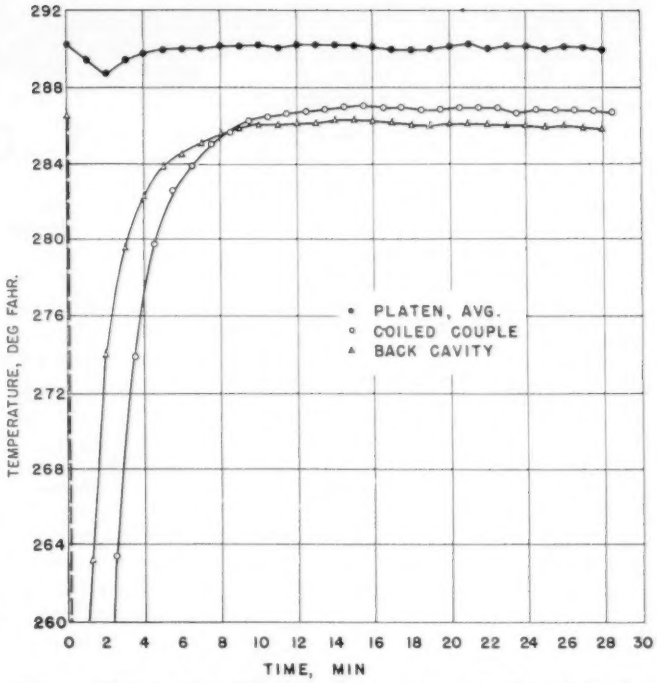


Fig. 4.—Relationship Between Temperatures Indicated by the Platen Thermometers, the Thermocouple in the Back Plunger, and a Thermocouple Coiled in the Thickest Part of the Specimen.

were then carefully removed from the machine and cut in half, along the small fin left at the point where the dies meet, with a sharp knife. After these specimens had been cooled down to room temperature, the front plunger was removed, the thermocouple to be coiled was inserted through the plunger hole in the platen, brought out through the die cavity and between the platens, inserted through the hole left in the top half of the specimen by the front plunger, and coiled at least one full turn on the thickest portion of the specimen, with the junction in the desired location. In order to hold the thermocouple junction in the desired location while the specimen was being placed in the machine, it was fastened to the top half by pushing the junction through a thin bit of the specimen which had been pierced with a sharp needle. The coil was also held in place at three other points with small staples. While the thermocouple was being fastened to the specimen, the machine was kept at the test temperature by holding the dies open just enough so that the thermocouple wires would not be cut. The specimen was then inserted in the machine in the same position it had held while being formed. Even with the above precautions, several tests would usually have to be made in order to get one where the coiled couple junction remained exactly in the center of the specimen, as judged by eye after removal of the specimen from the machine.

The results are shown in Figs. 2 to 11, inclusive. In Figs. 4, 5, 6, 7, and 11, the average platen temperatures are shown as a matter of convenience. In none of these cases, however, did the platen temperatures differ from each other by more than 0.5 F at any time.

Discussion of Results

The equilibrium temperature conditions shown in Fig. 2 illustrate several temperature characteristics. First, the degree of control that can be obtained with an adequately controlled Mooney viscometer is well within ±0.5 F. Second, the temperature difference between the die cavity and the platen thermometers is slightly more than 3 F at a test temperature of 287 F and 1 F at a test temperature of 212 F for this particular machine. Third, the difference in temperature between the front and the back part of the die cavity is about 1 F for this machine at 287 F and about 0.8 F at 212 F. Fourth, the average value obtained by connecting the front and back thermocouples in parallel, in accordance with Tentative Method D 1077 – 49 T, gives a true average. Thermocouples with their junctions pressed against the inside of the die surface, under these same equilibrium temperature conditions, produced data which corroborate those shown in Fig. 2. Except for one or two positions, temperatures observed for corresponding points on the top and bottom die were in very good agreement. Also, interchanging the front and back thermocouple did not affect the results obtained.

On different machines, both lesser and greater differences have been observed between the temperatures indicated by front and back thermocouples and between the average die-cavity reading and the platen temperature.

Having established the equilibrium temperature characteristics with the machine empty, the next step was to determine whether or not these temperatures could be maintained with rubber in the machine. Figure 3 shows the results for a test temperature of 287 F. There is a drop of about 2 F in the platen temperatures when the sample is placed in the machine and about six minutes are required for return to equilibrium. The amount of drop and the time of recovery for the platen temperature depend somewhat on the place in the heating cycle where the specimen is introduced. Variations of approximately ±0.5 F during the first 5 min have been observed from one test to another. The die-cavity temperatures also experience variation for the same reason but to a much lesser extent. The minimum temperatures observed for the die cavity occur about 10 sec after contact is made between the thermocouples and the rubber, and are approximately 210 F for a test temperature of 287 F and about 160 F for a test temperature of 212 F. The bottom portions of the die-cavity temperature curves are omitted as a matter of convenience. It will be noted that equilibrium is attained in about 10 min, and thereafter the values agree with those shown in Fig. 2 within the limits of normal variations. The heating char-

acteristics employed for these tests appear to be about optimum. By increasing the heat increment, equilibrium conditions can be obtained in less time but not without greater cycling of the platen temperatures and considerably less reproducibility of die-cavity temperature curves from one test to another. Shearer and his co-workers[6] appear to have obtained equilibrium temperatures in somewhat less time, presumably because they used steam heat with specially constructed platens.

The question naturally arises as to whether the thermocouple design used measures the true temperature of the rubber at the junction, or if the value observed is merely a reflection of the platen temperature. In order to check this, the front plunger thermocouple was removed and a thermocouple with a silver-soldered junction was inserted through the plunger hole and coiled in the thickest portion of the test specimen with the junction located at different points throughout the sample. Typical results are shown in Figs. 4, 5, and 6.

It was found that values obtained by the coiled couple relative to those obtained by the back plunger thermocouple depended to a very large degree upon the location of the coiled couple junction. Preliminary tests made before adequate controls had been placed on the viscometer indicate that if the junction is placed too near the outside of the specimen, either top, bottom, or sides, the temperature curve obtained with the coiled couple would rise above the back plunger thermocouple temperature curve within less than 0.5 min and would remain there until near equilibrium temperatures were reached. Its final value relative to the plunger thermocouple temperature curve depended on the exact position of the thermocouple junction. If the coiled thermocouple junctions were too near the rotor, the same conditions prevailed, except that the curves crossed before equilibrium was reached and the final value obtained with the coiled couple was always low.

On one test where the coiled thermocouple junction was forced against the rotor, the equilibrium temperature indicated was 0.4 F below that indicated by the back plunger thermocouple, which would make it about 0.9 F below the average plunger thermocouple reading. For the data in Figs. 4 and 5, the deviation of the coiled thermocouple junction from the exact center could not be detected by eye, while in Fig. 6 it was displaced slightly toward the rotor. In all three figures, the initial part of the curve for the coiled couple lags—that for the back plunger couple by approximately 1.5 min. Here, again, the first parts of the curves were omitted as a matter of convenience. The portion of the curves omitted is comparable to the one shown in Fig. 7 for the machine not running. The 1.5-min lag on first glance appears to indicate that the plunger thermocouples are in considerable error. This indicated error is not so great as it seems, however, as may be seen from a full consideration of all of the facts.

To begin with, the coiled thermocouple does not measure the average temperature of the test specimen but the lowest temperature, at least during the heating-up period. Also, the temperature at the coiled thermocouple junction starts at room temperature, and, since the mass of the thermocouple is small, it affects the temperature in the neighborhood of the junction very little. On the other hand, the mass of the plunger thermocouple is relatively large and its temperature is equal to the test temperature at the instant the rubber is placed in the machine. The initial minimum temperature indicated is therefore considerably higher than room temperature. Its value is determined by the amount the rubber in the immediate vicinity of the thermocouple junction is heated up by the plunger.

It is significant that after the minimum value is reached by the plunger thermocouple, the rate of increase is essentially the same for the temperatures indicated by both the plunger thermocouple and by the coiled thermocouple. This indicates that the temperatures observed with the plunger thermocouples are not merely a reflection of the upper platen temperature but are actually very close to the true temperature of the rubber at the thermocouple junction when the platen temperatures are equal. If this were not so, one would expect the rate of in-

[6] R. Shearer, A. E. Juve, and J. H. Musch, "Measurement of Scorch and Cure Rate of Vulcanizable Mixtures Using the Mooney Viscometer," *India Rubber World*, Vol. 117, p. 216 (1947).

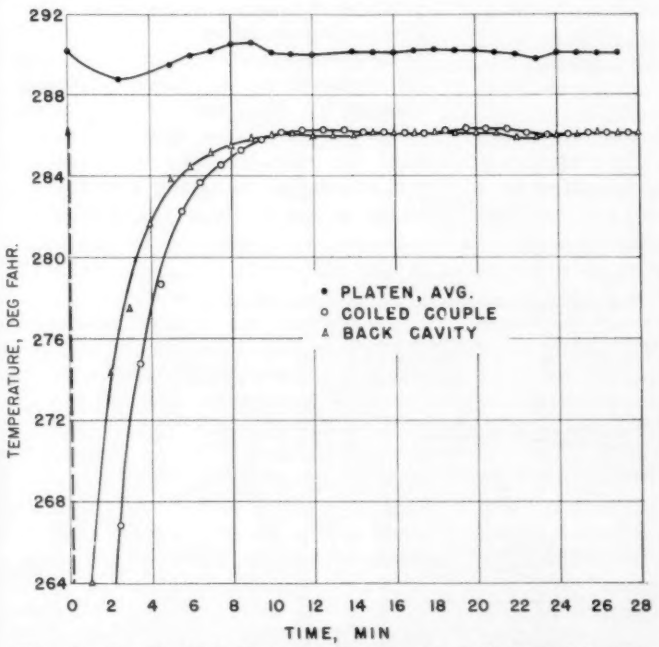


Fig. 5.—Relationship Between Temperatures Indicated by the Platen Thermometers, the Thermocouple in the Back Plunger, and a Thermocouple Coiled in the Thickest Part of the Specimen.

Junction of coiled couple in center of specimen near position of front plunger thermocouple—machine not running.

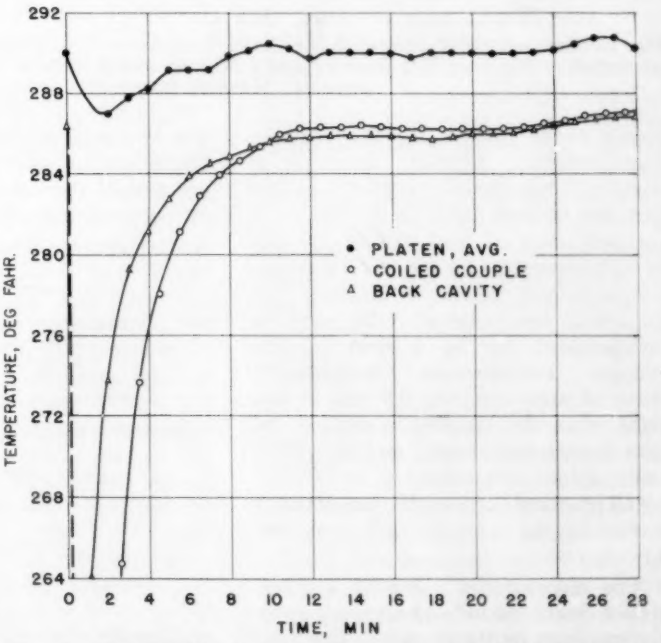


Fig. 6.—Relationship Between Temperatures Indicated by the Platen Thermometers, the Thermocouple in the Back Plunger, and a Thermocouple Coiled in the Thickest Part of the Specimen.

Junction of coiled couple in center of specimen near position of back plunger thermocouple—machine not running.

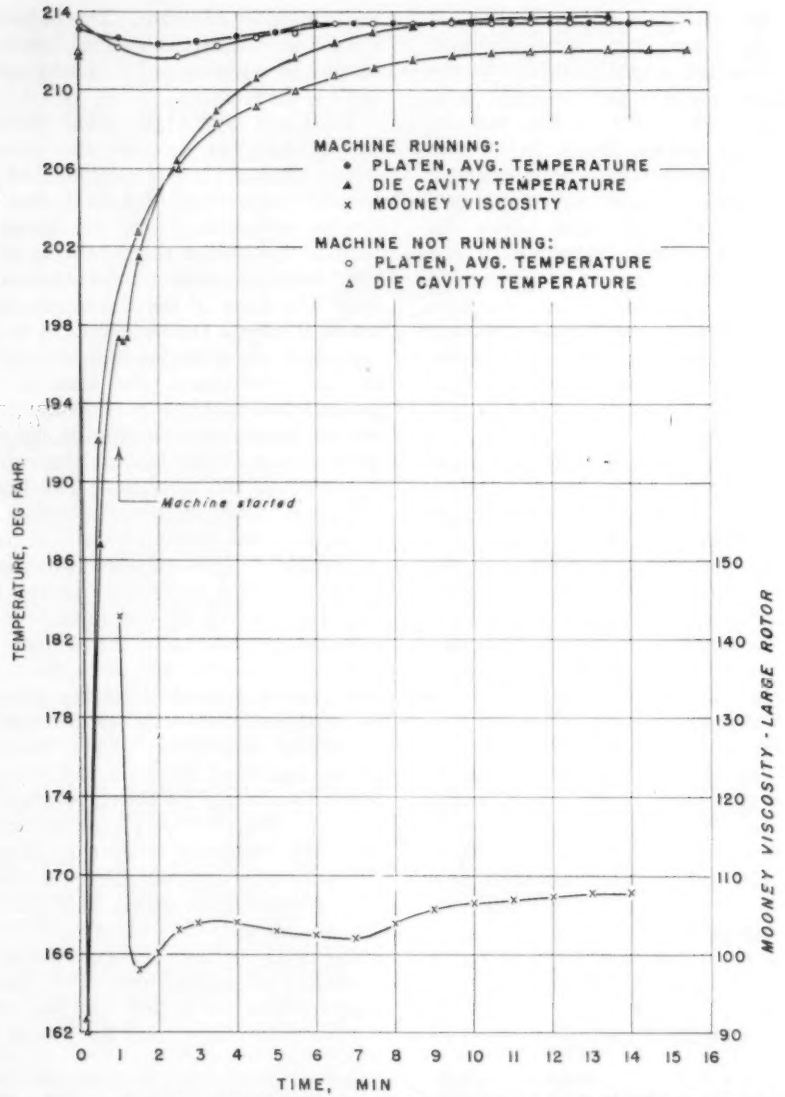


Fig. 7.—Comparison of Indicated Die-Cavity Temperatures with Rubber in the Mooney Viscometer—Machine Not Running and a High-Viscosity Rubber in the Mooney Viscometer—Machine Running.

crease to be greater for the plunger thermocouple. Actually, there is a slightly higher rate of increase during the first few seconds after the minimum is reached, since at that instant the lag of the temperature for the coiled thermocouple is only about one minute. In an actual test, however, this error is compensated for by a shift in the plunger thermocouple temperature curve of approximately 0.5 min to the right when the machine is started, as may be seen from Figs. 7 and 10. Thus under actual prescribed test conditions, for all practical purposes the rate of rise is essentially the same for both temperature curves.

The difference in value at a given time is due to the initial heat given up to the specimen by the plunger. The heat subsequently transferred through the plunger to the specimen is no greater than that transferred by other means. It should be borne in mind that although the temperatures indicated by plunger thermocouples during the first 10 min are higher than those indicated by a coiled thermocouple with its junction in the center of the thickest portion of the specimen, they would also be lower than those indicated by a coiled couple with its junction near the die surfaces. Since, therefore, one plunger thermocouple is located in the coldest portion of the die cavity and one in the hottest portion, it appears that the average values obtained are reasonably acceptable values for the over-all average of the specimen. In addition, as may be seen from a comparison of the curves in Fig. 7, the viscosity of the sample has a pronounced effect on the temperature of the test specimen.

The variation in temperatures which may be expected at different points around the dies, due to temperature gradients, are illustrated in Figs. 8 and 9. Figure 8 shows the relationship between equilibrium temperatures in the platens, the die cavity, and in the upper and lower dies at the positions illustrated in Fig. 1. Figure 9 shows the variation in temperatures at the four positions in the upper and lower die as compared with the platen temperature. The data for this figure were taken from test No. 3 shown in Fig. 10. It is of interest to note that for this machine temperatures in the upper die are fairly uniform except for position 3, which is the right side, while the temperatures in the lower die differ not only in value but also in rate of change.

The question which naturally arises then is—would it be practical to select some point in the dies or die holders from which the temperature of the die cavity could be controlled, and the temperature of which would bear the same relationship to the average temperature of the test specimen for all machines and for rubbers having widely different viscosities? The answer appears to be "No." Such a point could readily be used for controlling the temperature, but to establish a control temperature which would insure comparable tem-

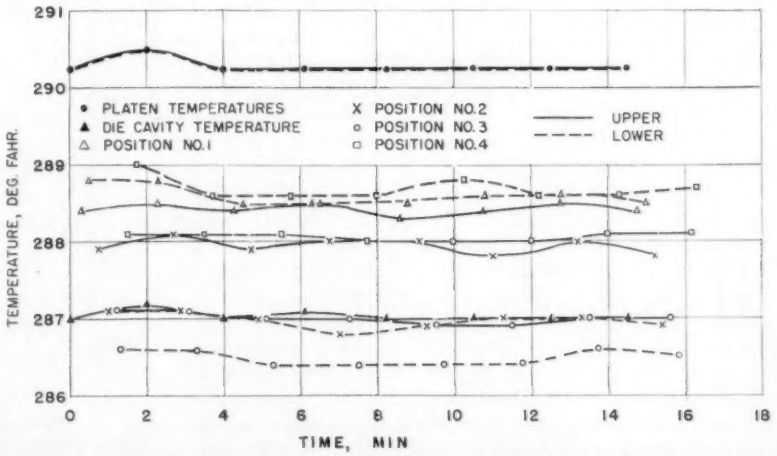


Fig. 8.—Relationship of Equilibrium Temperatures at Different Positions in the Dies of the Mooney Viscometer—Machine Closed, Empty, and Not Running. See Fig. 1 for Positions.

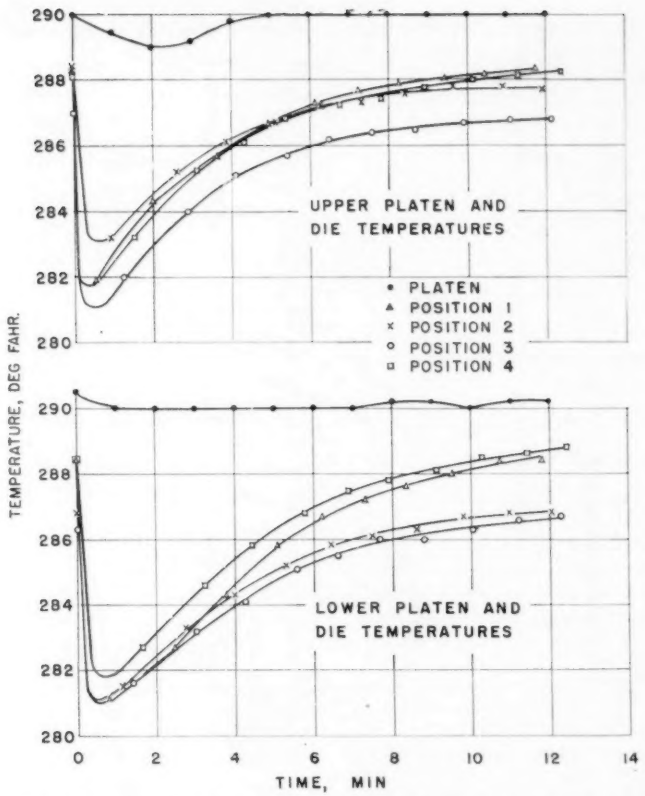


Fig. 9.—Relationship of Temperatures of Four Different Positions in Each Die of the Mooney Viscometer During an Actual Test. Data Are Taken from Test No. 3 Shown in Fig. 10.

peratures in test specimens in different machines does not seem feasible. It has already been pointed out that the temperature gradients from the die cavity to various points in the dies and platens and even within the die cavity itself vary considerably, not only from one machine to another but within a given machine. Furthermore, these gradients apparently differ widely in pattern as well as degree for different machines and different methods of heating.

Figures 8, 9, 10, and 11 show there is a relationship between die temperatures and the die-cavity temperatures, but a comparison of relative platen, die, and die-cavity temperatures in Figs. 7 to 11 also show that the relationship is dependent on the viscosity of the sample being tested, as was shown in Fig. 7. While one set of curves shown in Fig. 7 was taken with the machine not running, the temperature curve obtained would be comparable to those obtained in testing a low-viscosity rubber. Note that this is also borne out in Fig. 10. While the stock remains at a low viscosity, the die-cavity temperature approaches the test temperature of 287 F, approximately 3 F below the temperature of the dies. However, as soon as the stock begins to cure and the viscosity begins to rise, the temperature also begins to rise and would soon reach the value shown for the dies if the test were continued.

Shearer[6] has shown that cure curves obtained with the Mooney viscometer have a temperature coefficient of approximately two. One should be able, therefore, to determine quite accurately the error of the indicated die-cavity temperature curve due to unequal platen temperatures by making actual cure tests. The curves shown in Figs. 10 and 11 were obtained with this idea in mind. Tests Nos. 2 and 3, Fig. 10, were made with the platen temperatures equal and the correlation between the viscosity curves and the die-cavity temperature curves is excellent. Test No. 5 was made with the upper platen approximately 4 F above the temperature of the lower platen, and test No. 6 was made with the lower platen approximately 4 F above the temperature of the upper platen. Since the indicated die-cavity temperatures are essentially the same for all four tests while the viscosity curves differ, there is no question but that unequal platen temperatures will cause error in the indicated die-cavity temperatures. From Fig. 11 it can be seen that in the neighborhood of 287 F test temperature, if the test temperature is raised or lowered approximately 4 F the viscosity will be 1 min faster or slower, respectively. It is therefore evident from Fig. 10 that the indicated die-cavity temperature curve for test No. 5 is approximately 1.35 F too high and that for test No. 6 is approximately 1.35 F too low. A cursory examination of Figs. 10 and 11 might lead one to suppose that the correlation of mean die temperatures with the viscosity curves is quite good, whether the platen temperatures are equal or not. Actually, it can be shown that the error of the indicated die temperatures for a 4 F differential in platen temperatures is 0.6 F or almost half as much as with the die-cavity temperatures.

It should also be pointed out that each die-temperature curve in Figs. 10 and 11 is the mean of the eight individual die-temperature curves for each respective test and comparable to those shown in Fig. 9. The mean curves were obtained by taking the mean of the eight temperature values read from the eight individual curves at the times indicated by the points plotted. Thus we see that mean die temperatures are less affected by variations in platen temperatures than are die-cavity temperatures. Error is introduced into the die temperatures by variation of platen temperatures, nonetheless, and in addition, the practical aspects from an operational point of view greatly favor the measurement of temperature in the Mooney viscometer as specified in ASTM Tentative Method D 1077 – 49 T.[3]

Whether or not a significant error is introduced when the platens are at different temperatures is of no importance, provided, in making a test, the specified method (either ASTM Tentative Method D 1077 – 49 T[3] or ASTM Tentative Method D 927 – 49 T[7]) is followed explicitly. The authors of the two methods were fully aware of the possibility of error due to difference of temperature in the platens, and the above methods therefore require that the platen temperatures shall be equal to each other within ±0.5 F. It is particularly important that the platen temperatures be maintained equal while test temperature conditions are being established as outlined in the above methods.

Conclusions

The control of the temperature of the test specimen and its measurement in the Mooney viscometer presents a difficult problem, which in all probability will not be adequately solved until the nonsymmetrical characteristics of the machine are corrected by a new design. In the meantime, however, some method of indicating the actual temperature of

[7] Tentative Method of Test for Viscosity of Rubber and Rubber-Like Materials by the Shearing Disk Viscometer (D 927 – 49 T), 1949 Book of ASTM Standards, Part 6, p. 1159.

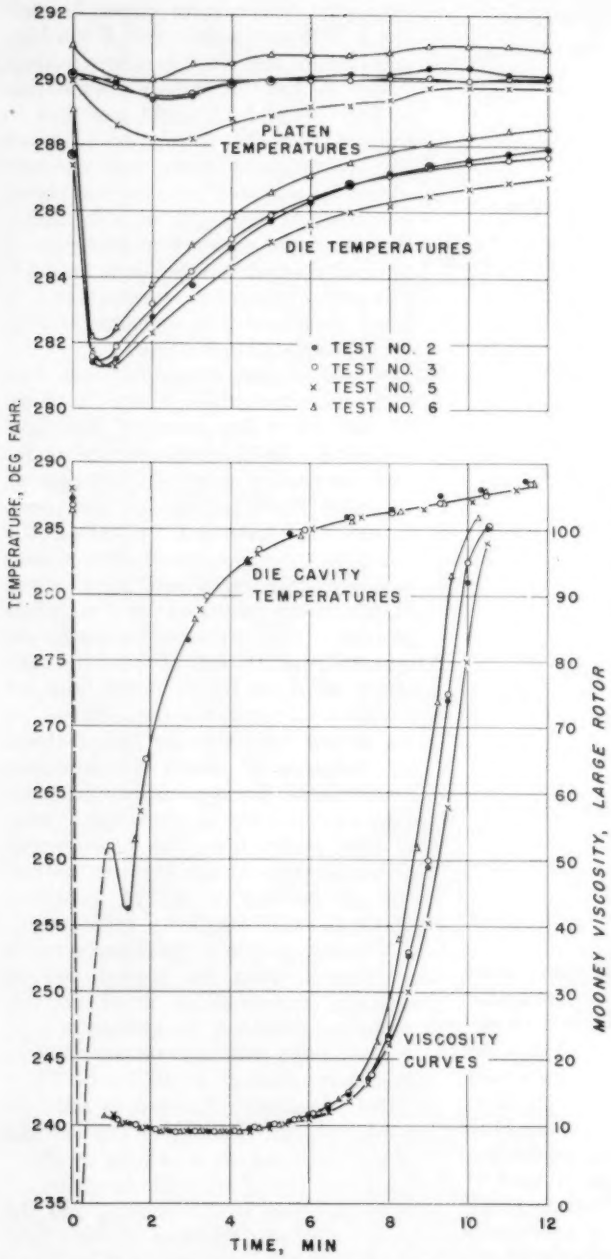


Fig. 10.—Effect of Unequal Platen Temperatures on the Relationship of the Indicated Temperature of the Die Cavity to the Viscosity Cure Curve in the Mooney Viscometer.

Tests Nos. 2 and 3: Platen temperatures equal. Test No. 5: Temperature of top platen 4 F higher than temperature of bottom platen. Test No. 6: Temperature of top platen 4 F lower than temperature of bottom platen. Platen and die-temperature curves are average. Each die-temperature curve shown is average of temperature curves for eight positions similar to those shown in Fig. 9.

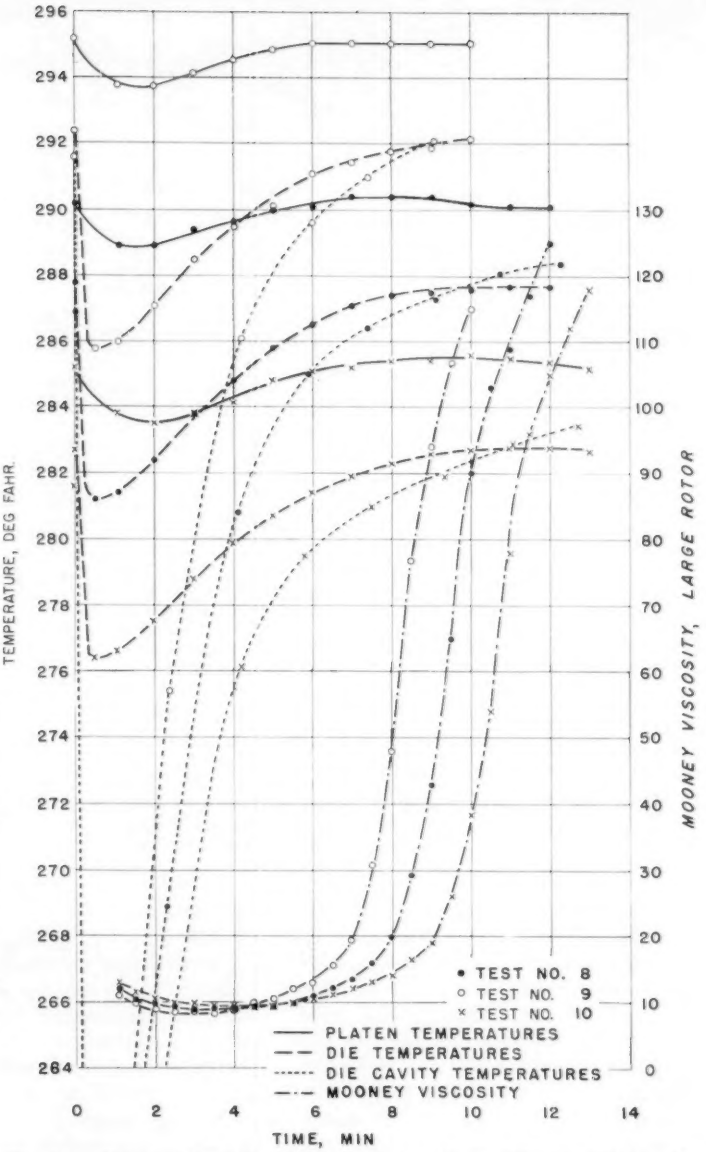


Fig. 11.—Effect of Variation of Temperature in the Mooney Viscometer on the Viscosity Cure Curves.

the test specimen as a basis for temperature control must be employed if reliable results are to be obtained.

Measurement of the temperature at specified points in platens, dies, or die holders may be satisfactory for control testing, but it is not adequate for obtaining comparable temperatures from one machine to another for two reasons: (1) the temperature gradients from one machine to another vary widely both in pattern and degree; and (2) the viscosity of the test specimens has a pronounced effect on its temperature curve while thermocouples in the dies are relatively insensitive to this effect.

Thermocouples conforming to the design specified in ASTM Method D 1077 – 49 T appear to be satisfactory provided either ASTM Tentative Method D 1077 – 49 T or ASTM Tentative Method D 927 – 49 T, depending on the test to be made, is followed explicitly. There is no question about the results obtained with an individual machine. There may be some question as to whether or not they will properly indicate the temperature in different machines, since this point has not been definitely determined one way or the other. The fact that the temperatures indicated by these thermocouples at equilibrium agree well with temperatures of the inside surfaces of the dies and that the rate of temperature change with a specimen in the machine agrees with that obtained by means of a thermocouple coiled in the specimen, is strong evidence that the thermocouples may be expected to properly indicate temperatures in different machines.

For precise results in making cure tests with the Mooney viscometer, precise temperature measurements are essential, and if good reproducibility of the viscosity-time curve is required, accurate temperature control is just as important.

Style in Engineering Writing

EARL S. LAMM, former Assistant Professor of General Engineering at Purdue University, in the May, 1951, *Journal of Engineering Education* wrote a succinct article on the subject indicated, and he closes with three examples of different styles that can be used in presenting a similar idea.

He notes that "the engineer is usually trying to express something concrete and therefore the style which he should choose is the formal style. This style is free from vulgarisms, colloquialisms, dialect, and slang; it is also free from big words where a simpler word will do. It uses neither the short cuts, characteristic of the less formal styles, nor the overelaborate constructions of the literary style. Though it lacks emotional appeal, it is clear, concise, and logical.

"Here is an example of similar ideas expressed in some of the different styles compared above:

(*a*) *Formal style:*

"The engineer should be aware of the applications of the scientific method to fields other than his own. For example, he should understand the basic principles of industrial psychology which result from the scientific study of human relations, because if he is successful he will spend a surprisingly large part of his time simply in dealing with people."

(*b*) *Literary style:*

"A member of the engineering profession should be cognizant of the utilization of the methods based on the systematic classification of knowledge in realms which are exclusive of his major field of preoccupation. Focusing our attention on only one phase, we see that he must necessarily be well grounded in the basic psychological end products of the dynamics of the exploration and classification of anthropological relationships which fall within the range of industrial usefulness, since, as a responsible member of his profession, he will be required to spend an astonishingly large proportion of his time in interaction with other members of various social units.

(*c*) *Combination slangy and colloquial style:*

"A slipstick artist's gotta savvy how the brainpower's being worked in other rackets. Fer instance, he's gotta know the up-to-date ways of digging other people on the job, because if he's a B.T.O.,* he's tripping over folks all the time."

Plaster Failures Resolved

HYDRATED limes for white-coat finishing plasters having improved structural qualities are now being manufactured as a result of research carried out at the National Bureau of Standards. These studies were prompted by wide spread blister-type plaster failures which exact an annual toll of millions of dollars and revealed that the failures were caused by the expansion of one of the components of the partially hydrated "dolomitic" lime used extensively throughout the country for preparing finishing plaster. This component—unhydrated magnesia—was found to be characteristic of a large percentage of such limes. Methods for treating the lime and decreasing the unhydrated magnesia have been developed by the Bureau in cooperation with industry and have already been introduced into commercial production. Plasters made from lime that is produced in this way are not subject to the blister type of failure. *ASTM* and the Federal Government have now adopted new specifications for finishing lime that are based on these findings.

* Big-time operator.

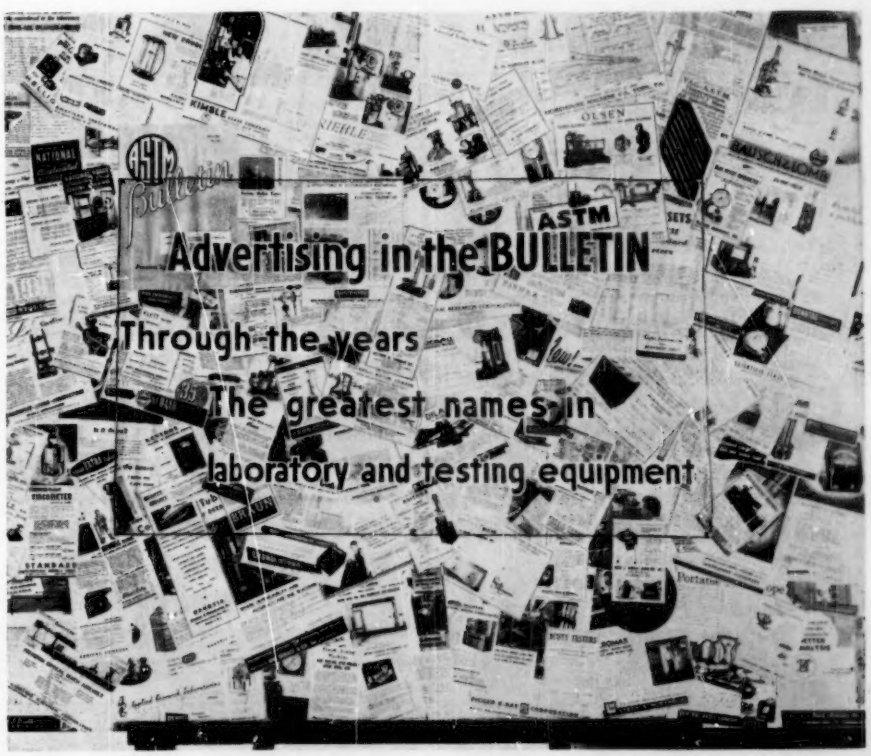
The 1951 Municipal Year Book

An authoritative résumé of activities and statistical data of American cities, published by the International City Managers' Association, this comprehensive, practical reference volume contains valuable information and statistics essential to officials in every city department. It is probably the most useful single reference source on municipal government trends and activities in the United States. As noted by the editors, Clarence E. Ridley and Orin F. Nolting, municipal problems increase each year, and it is of invaluable help to those concerned with city government to know how other cities arrive a proper solutions.

In compiling this annual (now in its 18th edition) the editors rely on the cooperation of many officials and other specialists in the governmental field—data, developments, analyses, and interpretations being reported by nearly five thousand municipal officials, 48 state correspondents, editorial consultants, special contributors, various state and federal officials, and the headquarters staffs of professional and technical organizations.

The five main parts of the book cover: Governmental Units, Municipal Personnel, Municipal Finance, Municipal Activities, and Directories of Officials. There are many charts and statistical tables, and new features in the 1951 edition, of course, include 1950 U. S. Census figures. All the information is highly organized for immediate tapping. There is an extensive subject index which includes references to selected material in previous issues not repeated in this edition. The book also is neatly thumb-indexed under the following headings: Government Data, Salaries, Personnel, Revenues, Finance, Purchasing, Planning, Housing, Building Inspection, Fire, Police, and Ordinances.

Attractively bound in maroon cloth, this 590-page book (6½ by 9¾ in.), obtainable from the ICM Assn., 1313 E. 60th St., Chicago 37, Ill., sells for $10.



Located adjacent to the Registration Desk, this sign drew much interested comment from those attending the Annual Meeting in Atlantic City. The sign, a montage of ads past and present appearing in the BULLETIN, pointed up the value of the advertising pages in keeping the members and subscribers informed of the latest in laboratory supplies and testing equipment.

It was also interesting to note that many of the advertisers in the BULLETIN issues of the mid-twenties still appear regularly.

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